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FIELD MEASUREMENTS OF NATURAL NO_x EMISSIONS FROM SOILS - EGBERT, ONTARIO, JULY-SEPTEMBER, 1989

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ABSTRACT

Field measurements of NO_x emissions from soil were carried out at the Centre for Atmospheric Research Experiments (CARE), Egbert, Ontario from July to September, 1989 as part of a program to characterize natural NO_x emissions for regional oxidant modelling. NO fluxes ranged from 0.3 to 11.6 ng(N) $m^{-2}s^{-1}$ over a total of 50 measurements. NO_2 fluxes were much smaller. NO fluxes exhibited a pronounced diurnal variation that correlated with soil temperature. Watering soils to simulate rainfall increased NO fluxes by a factor of 4.6 to 5.4. NO flux measurements in this study were of similar order of magnitude to previous measurements made in the U.S.A., Europe and Australia.

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1.0 INTRODUCTION

Atmospheric NO and NO_2 (referred to collectively as NO_x) participate in a complicated series of sunlight-initiated chemical reactions with various volatile organic compounds (VOC) to give rise to the net formation of photochemical oxidants, such as ozone (O_3) and peroxyacetylnitrate (PAN), which have been implicated in health effects and crop damage (Lin 1989). Well known sources of NO_x and VOC are motor vehicles and the combustion of fossil fuels for heating and electricity generation. Less well known is the fact that significant natural emissions of VOC and NO_x occur. Natural hydrocarbons, such as isoprene and terpene, are emitted by vegetation and NO_x is released from soils through microbial action. About 15 % of the tropospheric source term for NO_2 is estimated to originate from soil, whereas about 63 % is anthropogenic due to fossil fuel combustion and biomass burning (MacKay 1988). The remaining 22 % is from sources such as lightning and NH_3 oxidation.

A natural oxidant background therefore exists in the atmosphere. Oxidant levels are, in general, expected to be increased by the addition of anthropogenic pollutants, however, the relation between the amount of a pollutant released at a particular point and the oxidant levels resulting far downwind is very complicated. NO releases, for example, may lead to a local reduction in ozone, due to the reaction $NO + O_3 \rightarrow NO_2 + O_2$, but lead to enhanced O_3 production further downwind where NO_x can catalyze the formation of O_3 through reaction with VOC entrained into the plume. The impact of a source, or set of NO_x sources, on oxidant levels must be calculated by mathematical models which describe oxidant formation, transport and depletion on a regional basis. A knowledge of the natural emissions of key reactants is important to correctly model the impact of NO_x emissions from industrial activity, particularly as natural emissions occur over large regional scales and form the "chemical background" into which anthropogenic pollutants are emitted.

Ontario Hydro emits NO_x as a result of combustion of fossil fuels for electricity generation. These emissions may contribute to regional episodes of high O_3 concentration as observed frequently in Ontario during the summer of 1988 (where the 1-h average Canadian Air Quality Objective for Maximum Acceptable O_3 concentration of 80 ppb was often exceeded). Rational decisions on the implementation of any emission controls require that the contributions of each source be defined and also that the effect of reducing emissions on ambient ozone levels be predicted. Regional oxidant models of the type discussed above will likely be used for this purpose.

Measurements of natural nitric oxide, NO, and nitrogen dioxide, NO_2, emissions from soils were made at the Centre for Atmospheric Research Experiments (CARE), Egbert, Ontario from July to September, 1989. This report documents the results.

The present work represents part of a program with the long-term goal of defining natural NO_x sources on a regional and seasonal basis for southern Ontario as an input to modelling studies, as very little information exists in this regard. Under this program, field measurements will be made at various sites under various seasonal conditions to examine the factors that determine emission rates for various representative categories of soil type and land use, and the variation of these fluxes with environmental conditions. For the remainder of 1989, plans called for further experiments at Egbert to determine the variation of NO_x emission fluxes with season, and for a short study of emission fluxes from a forest floor at Borden, Ontario.

The field studies are being conducted in parallel with a series of laboratory measurements (by the Biological Research Section of Ontario Hydro Research Division) on soil samples taken from the field. It is hoped that the laboratory measurements can supply detailed mapping of NO_x emission rates for soil types representative of southern Ontario. Soil samples will be taken from our experimental field sites and tested in the laboratory to ensure that the laboratory measurements give representative fluxes.

The NO_x flux measurement procedure used was based on the closed chamber technique employed by various groups in Europe and the USA (Johansson and Granat 1984, Parrish et al 1987, Williams et all 1987, Anderson and Levine 1987). The apparatus was field tested at Egbert in 1988 and preliminary flux measurements were obtained (Mackay and Ogram 1989). Further background on natural NO_x emissions and their relation to the chemistry of oxidant formation may be found in an earlier report (Mackay 1988).

1.1 Objectives

The specific objectives of the July-September, 1989 Egbert field study were to determine the representativeness of field measurements by examining the spatial variability in measured fluxes within a nominally uniform field, and to examine the effect of diurnal variation and simulated rainfall on NO_x soil emissions. NO_x soil emissions were also examined on a field with alfalfa crop and grasses, and on an adjacent field with sparse grass in order to determine if these two different types of vegetation cover had an effect on NO_x emissions.

2.0 EXPERIMENTAL METHODS

2.1 Flux Chamber

The experimental apparatus was similar to that used previously at Egbert for the preliminary measurements made during August and September, 1988 (Mackay and Ogram 1989). Figure 1 illustrates the chamber apparatus. The chamber (30 cm x 30 cm x 30 cm) was constructed of polycarbonate sheet and was lined internally with Teflon. A fan fixed to the chamber mixed the air within the chamber ensuring that a homogeneous atmosphere was created. During the experiments "zero" air generated by a calibrator (Monitor Labs Inc. Model 8550) was pumped into the chamber. The calibrator produced a "zero" air supply by drying ambient air and passing it through a chamber containing a UV lamp and charcoal trap, which removed NO_x and O_3 from the air stream. The "zero" air was pumped into the chamber at a rate of 4 L min^{-1} (for tests between July 10 to July 21) and 5 L min^{-1} (for tests after August 1). The chamber was vented directly to the atmosphere. The NO_x and NO_2 levels in the vent flow were measured using a Luminox LMA-3 NO_2 analyzer and LNC-3 NO converter. The sample air flow (1.5 L min^{-1}) was taken from a "T" junction on the vent line. For calibration purposes, a flow of NO standard gas (9.53 ppm of NO with about 0.11 ppm NO_2 impurity, Matheson) was diluted in the "zero" air stream from the calibrator.

The chamber was mounted on a steel, Teflon-lined skirt which was driven into the soil. The chamber could be raised and lowered automatically on a predetermined schedule to allow automated operation. The "zero" air stream could be switched by stainless-steel solenoid valves

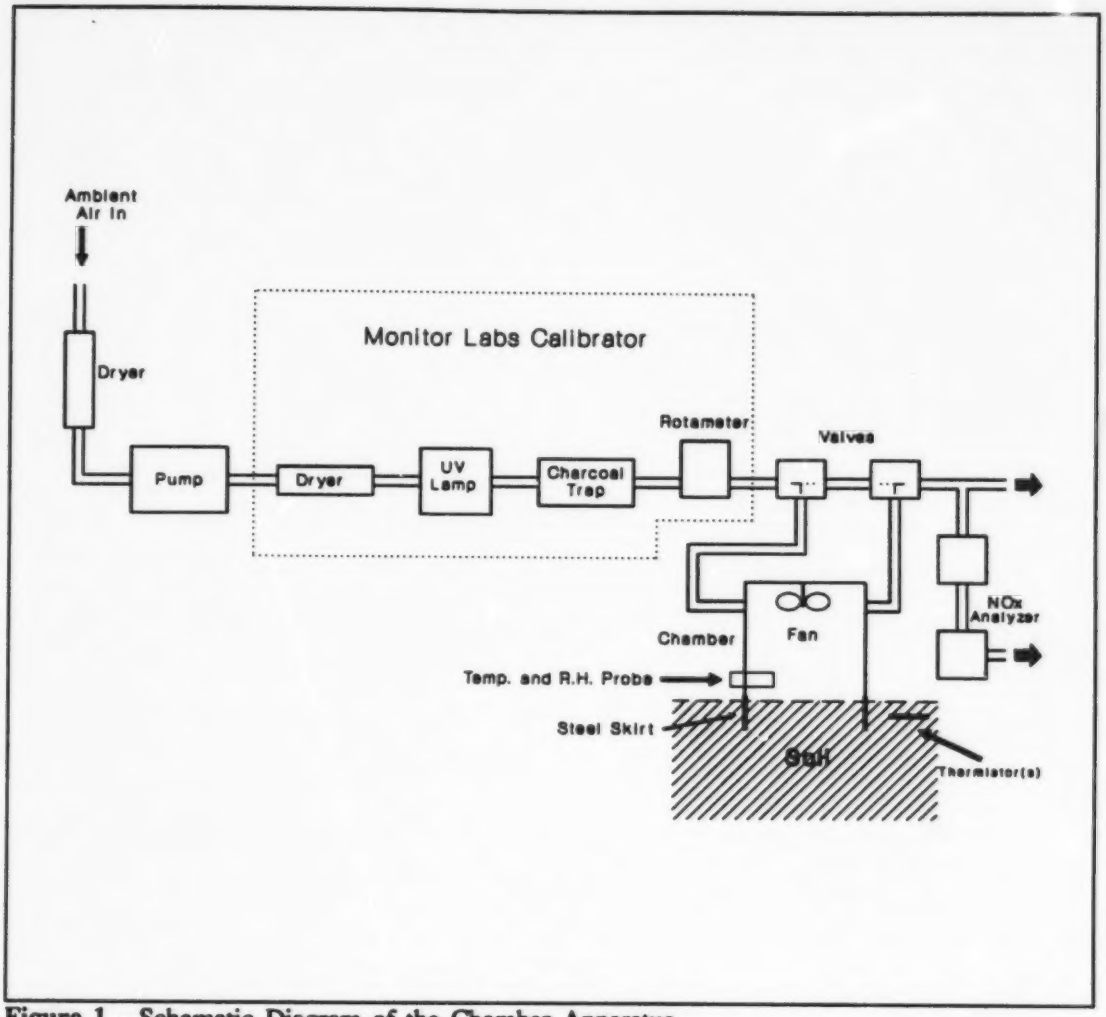


Figure 1 - Schematic Diagram of the Chamber Apparatus

(Ascolectric Ltd. cat.# 8320A200) to bypass the chamber completely. Bypassing the chamber enabled scrubbed air to be sampled to check the instrument zero. Automation of the system allowed unattended flux measurements to be taken for 24 h to observe diurnal trends.

The automated system was used only for the diurnal study. For all other runs, the chamber was operated manually. In both the automated and manual set-up, all data were collected by a Campbell 21X Data Logger. The Data Logger generated and stored 2 to 5 min averages of data sampled every 5 s. The logged data consisted of panel temperature (operating temperature for Campbell 21X), thermocouple measurements of soil temperature, barometric pressure, relative humidity (inside the chamber) and air temperature (inside the chamber). One minute averages of the LMA-3/LNC-3 output, taken every 5 s, were also outputted to final storage.

A second Data Logger, synchronized to the first, was used to control solenoid valve switching and chamber raising and lowering. During manual operation, chamber raising and lowering and switching of the air sampling streams was done manually. The LNC-3 NO converter was also manually switched between the NO_2 and NO_x mode. The monitor calibration was checked before and after each test. External air temperature and relative humidity were recorded and observations of weather conditions were made.

2.2 Field Tests

The test site was at the Centre for Atmospheric Research Experiments (CARE), Egbert, Ontario which is operated by the Atmospheric Environment Service of Environment Canada. The location and layout of the CARE site is shown in Figure 2.

The experimental sites were prepared using a sharp blade to cut the surface vegetation down to about 1 cm in height (being careful not to uproot the vegetation). With some plots, particularly those with low water content, the ground was so hard that a sod cutter was used to break the earth before hammering the steel skirt, on which the chamber was mounted, into the ground. Care was taken to disturb the soil within the plot as little as possible.

The approximate locations of the sampling sites are illustrated in Figure 3. In order to examine spatial variability, the sites were located roughly 10 m apart. Replicates, using separate plots about 1 m apart, were carried out at each site. Three sites on the alfalfa field and two sites on the grassed area were used. Three series of measurements over a full diurnal cycle were made at two sites on the alfalfa field.

Rainfall was simulated by irrigating a 30 cm x 30 cm plot with 0.9 L of demineralized water corresponding to 10 mm of rain. Flux measurements were made before and after watering.

For every plot examined at Egbert, soil core samples were taken to a depth of 10 cm. The samples (three combined for analysis) were taken at the beginning and end of each test. Soil specimens taken at the beginning of the test were removed from nearby the plot itself (usually 20 to 30 cm away). Soil cores taken after the test were sampled adjacent to the plot. Soil cores were stored in glass bottles and analyzed for bulk density (dry mass per unit volume of soil) and water content.

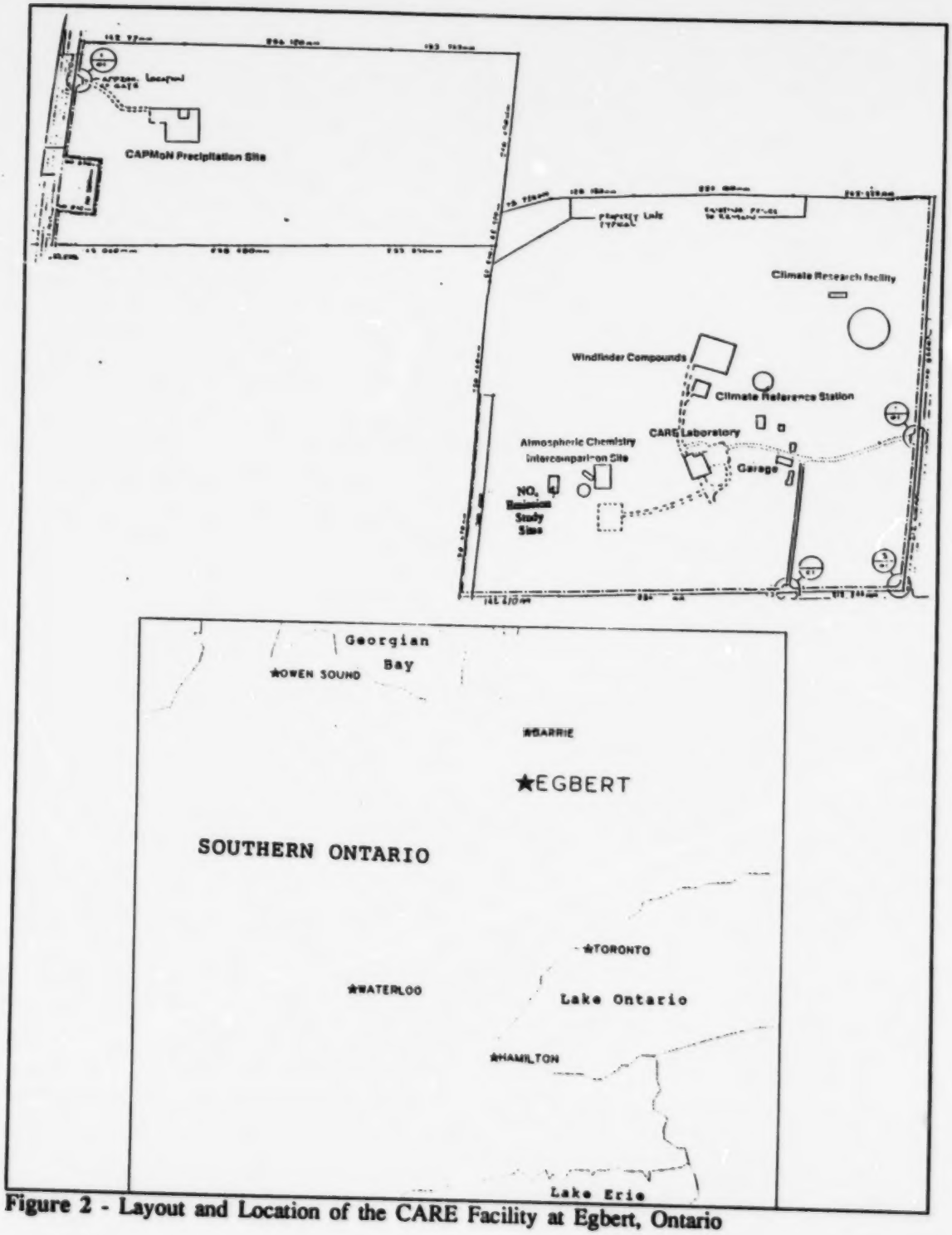


Figure 2 - Layout and Location of the CARE Facility at Egbert, Ontario

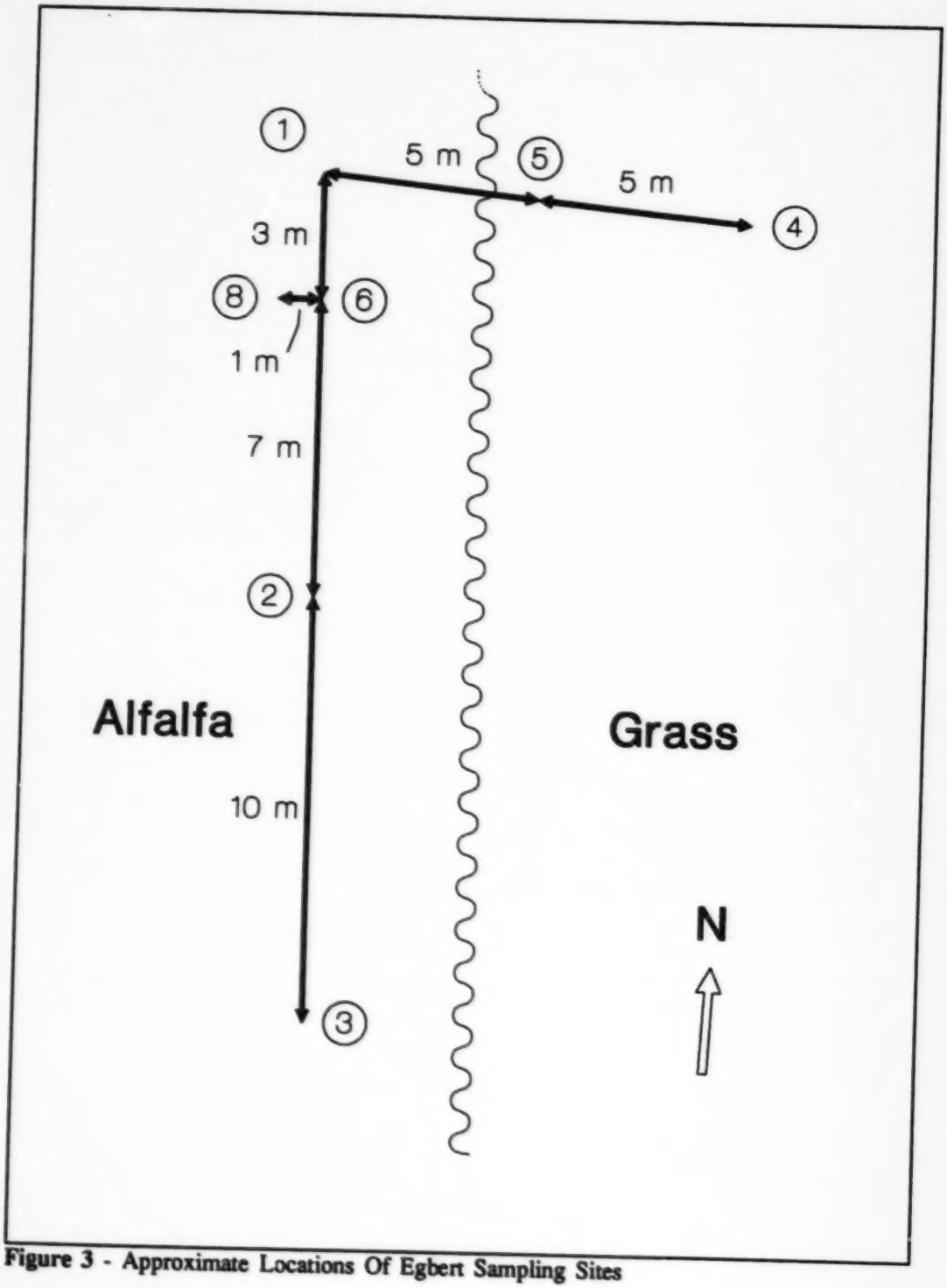


Figure 3 - Approximate Locations Of Egbert Sampling Sites

Additional soil samples were taken from each site for analysis at the University of Guelph and Agri-Food Laboratories for physical properties, pH and organic content. In order to determine total nitrate, soil samples were taken from each site at the beginning and end of the test series, stored in glass jars, frozen and later analyzed by the soil laboratory at the University of Guelph.

3.0 RESULTS AND DISCUSSION

Table 1 summarizes the Egbert tests, giving the site location (see Figure 3), the type of site and the date. Results are summarized in Tables 2 and 3, including the calculated NO flux, soil water content and soil free pore volume. Full data from each experiment are given in Appendix A. Appendix B describes the method used for deriving NO flux from the uncorrected [NO_x] and [NO_2]. Soil properties appear in Table 4.

At Egbert, small spatial variations around the same site (1 to 2 m in distance between plots) produced large variations in NO flux. The ranges of flux values from 3 nearby plots spanned factors of 3.6, 3.5 and 4.4 for sites 1, 2 and 4, respectively. However, within the same field type, much smaller variations in the average NO flux between sites were observed. The three alfalfa sites (spaced about 10 m apart) yielded average NO fluxes of 5.5, 6.0 and 6.3 ng(N) $m^{-2}s^{-1}$ for sites 1, 2 and 3, respectively, suggesting that mean values over two or three plots located 1 or 2 m apart were reasonably representative of the site. The grass sites yielded average fluxes of 0.7 and 4.9 ng(N) $m^{-2}s^{-1}$ for sites 4 and 5 respectively. However, the difference between the average fluxes for sites 4 and 5 may have been caused by the generally higher water content of site 5, the proximity of site 5 to the alfalfa field (~2 m west from site 5), and the different weather conditions under which the tests were conducted.

The experiments at the grassed sites were conducted under markedly different weather conditions. Experiments at site 4 were conducted during sunny conditions with WSW winds, whereas those at site 5 were conducted in winds fluctuating from ESE to NNW with impending rain showers. Very similar weather patterns were observed for all tests at the three alfalfa sites, generally NNW winds with relatively clear skies (some cumulus and cirrus clouds), with daytime temperatures holding at ~27 °C for sites 1 and 2, and rising from 22 to 27 °C for site 3.

Simulated rainfall produced dramatic increases in both the NO flux and the time needed for chamber NO concentration, [NO], to stabilize at steady state. Figure 4 shows fluxes measured over the same plot (3), watered and with natural water content, as an example. Stabilization occurred after 20 min for natural replicates, whereas stabilization took more than 1 h for the watered replicates. It is speculated that the longer stabilization times observed for the watered plots corresponded to the slow penetration of water into the soil during the run, which may have stimulated biological activity at increasing depths. NO fluxes increased from 7.8 and 4.9 ng(N) $m^{-2}s^{-1}$ for the natural replicates, to 26.0 and 42.0 ng(N) $m^{-2}s^{-1}$ for the watered replicates. This represents an average increase in NO flux of a factor of 5.4 after watering. Site 5 yielded an average 4.6 fold increase in NO fluxes after watering, further verifying the trend.

Observed fluxes were plotted against various environmental parameters in an attempt to identify those factors primarily responsible for controlling emission fluxes. The following parameters were considered: soil temperature, chamber air temperature, elapsed time (for diurnal trends),

Table 1 - Soil NO, Emissions Measurements at Egbert, July to September, 1989

Run	Ground Cover / Conditions	Date
1a	alfalfa	July 10
1b	alfalfa	July 10
1c	alfalfa	July 10
2a	alfalfa	July 11
2b	alfalfa	July 11
2c	alfalfa	July 11
3a	alfalfa	July 13
3aw	alfalfa, watered	July 13
3b	alfalfa	July 13
3bw	alfalfa, watered	July 13
4a	grass	July 18
4b	grass	July 18
4c	grass	July 18
5a	grass	July 21
5aw	grass, watered	July 21
5b	grass	August 1
5bw	grass, watered	August 1
5c	grass	August 1
5cw	grass, watered	August 1
6c	alfalfa, diurnal	August 24-25
6d	alfalfa, diurnal	August 30-31
8	alfalfa, diurnal	September 12-13

Note: Run 6a was not included due to the chamber getting stuck in the up position. Run 6b was not included as the fan was not working. Run #'s indicate the plot (1,2,3,...) and the replicate (a,b,c,...).

Table 2 - Soil NO_x Emissions Measurements at Egbert, July to September, 1989 - Studies of Spatial Variability and Effect of Simulated Rainfall

SITE	Site Cover	Start Time	Chamber [NO] Steady State Conc. *	Chamber [NO] Stand. Dev. *	Cham. Air Temp.	Cham. [NO] *	NO Flux *	Cham. Rel. Hum.	Soil H2O Out. #	Soil H2O Ins. #	Free Pore Vol. Out.	Free Pore Vol. Ins.	Soil Temp.	Air Press.
			ppb	ppb	deg C	ng L^{-1}	ng $m^{-2}s^{-1}$	%	%	%	%	%	deg C	mb
1a	Alfalfa	1440	6.3	0.6	39.1	3.5	2.6	41.7	8.6	9.3	40.4	41.7	30.2	1007.7
1b	Alfalfa	1619	11.6	0.8	38.7	6.3	4.7	38.0	7.8	7.2	43.3	34.2	26.9	1006.0
1c	Alfalfa	1752	22.4	1.0	33.1	12.4	9.2	52.0	1.8	1.3	36.4	41.9	26.9	1005.0
2a	Alfalfa	1316	22.9	0.6	36.7	12.6	9.3	43.2	7.4	8.4	37.5		30.9	998.0
2b	Alfalfa	1446	6.6	0.3	35.0	3.7	2.7	38.6	7.4	9.2	40.5	26.8	27.8	998.0
2c	Alfalfa	1605	14.8	0.5	36.5	8.1	6.0	36.1	7.3	8.0	29.7	33.8	30.4	997.0
3a	Alfalfa	1221	18.9	0.2	34.2	10.5	7.8	43.8	6.0		46.4		23.4	1000.0
3aw	Alfalfa	1353	64.2	0.7	38.1	35.2	26.1	60.4		10.9		22.2	29.1	1001.6
3b	Alfalfa	1526	12.1	0.1	38.3	6.6	4.9	37.7	6.1		35.1		29.7	1002.0
3bw	Alfalfa	1657	103.4	3.5	37.8	56.7	42.0	64.4		7.5		31.5	27.6	1002.6
4a	Grass	1222	2.8	0.2	36.7	1.6	1.1	39.0	1.2	1.7	34.0	52.4	31.0	999.3
4b	Grass	1329	0.7	0.0	42.3	0.4	0.3	25.8	1.8	2.0	47.4	45.6	35.3	999.7
4c	Grass	1439	1.5	0.2	39.5	0.8	0.6	35.0	2.0	1.5	48.2	48.5	36.0	1000.0
5a	Grass	1300	5.1	0.2	37.1	2.8	2.1	33.9	1.1		44.0		23.0	995.0
5aw	Grass	1442	82.4	2.3	41.7	44.6	33.0	88.3		9.6		31.6	33.2	996.0
5b	Grass	1210	12.6	0.0	32.0	7.0	6.5	35.8	3.0		43.5		30.7	994.0
5bw	Grass	1336	36.4	0.3	33.0	20.3	18.7	33.5		10.6		26.7	32.8	995.0
5c	Grass	1508	10.1	0.3	32.0	5.7	5.2	34.4	2.1		44.3		38.3	996.0
5cw	Grass	1550	21.8	0.2	27.0	12.4	11.4	34.4		9.9		21.6	37.3	997.0

* ng = ng(N)
\# % = % by weight (0-10 cm core)
Out. = Cores taken adjacent to plot
Ins. = Cores taken from plot after experiment

Start Time (S.T.) = Time of first measurement used in flux calculation as follows

Natural - S.T. = t + 20 min
Soils - 5b, 5c - S.T. by eye from graph (when flux had reached approx. constant value)
- Diurnal (6b, 6c, 6d, 8) - S.T. = t + 40 min

Watered - S.T. = t + 60 min
Soils - 5aw - S.T. = t + 40 min
- 5cw - S.T. by eye from graph

Where t = time at which chamber was lowered to the soil

Table 3 - Soil NO_x Emissions Measurements at Egbert, July to September, 1989 - Diurnal Variation Studies

SITE	Site Cover	Start Time	Chamber [NO] Steady State Conc.	Stand. Dev.	Cham. Air Temp.	Cham. [NO] *	NO Flux *	Cham. Rel. Hum.	Soil H2O Out. #	Soil H2O Ins. #	Free Pore Vol. Out.	Free Pore Vol. Ins.	Soil Temp.	Air Press.
			ppb	ppb	deg C	ng L^{-1}	ng $m^{-2}s^{-1}$	%	%	%	%	%	deg C	mb
6c	Alfalfa	1432	17.7	0.4	38.6	9.6	8.9	33.1						
6c	Alfalfa	1632	13.9	0.7	34.6	7.7	7.1	40.4					27.3	996.0
6c	Alfalfa	1832	7.9	0.3	27.7	4.5	4.2	47.2					26.2	996.0
6c	Alfalfa	2032	6.2	0.1	15.4	3.6	3.4	69.9					22.9	996.0
6c	Alfalfa	2232	4.3	0.1	11.9	2.6	2.4	76.0					19.0	996.0
6c	Alfalfa	32	3.2	0.2	11.0	1.9	1.8	71.0					16.4	995.0
6c	Alfalfa	232	2.5	0.2	10.3	1.5	1.4	74.4					14.9	995.0
6c	Alfalfa	432	2.4	0.1	8.7	1.5	1.4	78.2					13.9	994.0
6c	Alfalfa	632	2.3	0.2	6.8	1.4	1.3	83.2					12.8	994.0
6c	Alfalfa	832	3.5	0.1	24.8	2.0	1.9	40.7					11.8	993.0
6c	Alfalfa	1032	6.7	0.6	33.2	3.7	3.4	33.8					13.4	992.0
6c	Alfalfa	1232	10.0	0.3	35.9	5.5	5.1	32.6					18.1	993.0
													25.7	993.0
6d	Alfalfa	1226	8.0	0.1	25.0	4.6	4.3	57.9						
6d	Alfalfa	1426	8.9	1.0	26.4	5.0	4.7	54.4					19.0	1004.0
6d	Alfalfa	1626	10.3	1.4	25.7	5.9	5.4	63.4					20.6	1004.0
6d	Alfalfa	1826	7.9	0.8	28.9	4.4	4.1	47.2					20.6	1003.0
6d	Alfalfa	2026	5.9	0.0	17.3	3.4	3.2	82.1					20.1	1002.3
6d	Alfalfa	2226	5.1	0.1	15.0	3.0	2.8	89.1					18.5	1002.0
6d	Alfalfa	26	4.6	0.3	13.8	2.7	2.5	92.8					17.1	1001.0
6d	Alfalfa	226	4.0	0.0	13.2	2.4	2.2	93.7					16.4	1001.0
6d	Alfalfa	426	3.6	0.0	11.9	2.2	2.0	95.8					15.6	1000.0
6d	Alfalfa	626	3.0	0.0	11.4	1.8	1.7	95.7					14.9	999.0
6d	Alfalfa	826	4.5	0.1	26.0	2.6	2.4	64.0					14.3	999.0
6d	Alfalfa	1026	7.5	0.3	37.3	4.1	3.8	48.0					15.2	998.0
													19.8	998.0
8	Alfalfa	1306	21.1	0.2	37.5	11.6	10.7	68.1						
8	Alfalfa	1506	11.3	1.1	36.5	6.2	5.8	64.9					20.9	995.0
8	Alfalfa	1706	9.9	0.3	26.6	5.7	5.2	92.4					22.0	995.8
8	Alfalfa	1906	7.3	0.4	19.8	4.3	4.0	104.7					20.9	996.0
8	Alfalfa	2106	7.3	0.1	16.2	4.3	4.0	106.7					19.5	995.0
8	Alfalfa	2306	8.4	0.1	14.2	5.0	4.6	107.0					18.1	994.0
8	Alfalfa	106	8.7	0.1	12.5	5.2	4.8	107.0					17.0	993.0
8	Alfalfa	306	8.5	0.1	11.0	5.1	4.7	106.9					16.0	993.0
8	Alfalfa	506	8.4	0.1	11.4	5.0	4.6	107.1					15.1	993.0
8	Alfalfa	706	8.2	0.2	11.7	4.9	4.5	107.2					14.6	993.0
8	Alfalfa	906	10.2	0.4	17.4	6.0	5.5	102.4					14.3	992.0
8	Alfalfa	1106	9.5	0.1	17.5	5.6	5.2	102.0					14.9	992.0
													15.5	991.0

* ng = ng(N)
\# % = % by weight (0-10 cm core)
Out. = Cores taken adjacent to plot
Ins. = Cores taken from plot after experiment

Start Time (S.T.) = Time of first measurement used in flux calculation as follows

S.T. = t + 20 min

where t = time at which chamber was lowered to the soil

Table 4 - Soil Properties at Egbert

Agri-Food Labs

Sample	pH	PO_4^- (ppm)	K (ppm)	Mg (ppm)	Ca (ppm)
1	7.6	10	99	97	4170
2	7.6	3	76	84	3091
3	7.3	3	51	79	2147
4	7.8	18	63	76	3276
5	7.6	13	59	68	3256
6	7.1	8	95	97	3242
8	6.8	7	70	77	2703

ppm = ppm on wt. basis

University of Guelph

Sample	NH^4-N (mg/kg)	NO^3-N (mg/kg)	pH	Org. Mat.(%)	Sand (%Wt.)	Silt (%Wt.)	Clay (%Wt.)
1	0.15	1.60	7.2	3.2	56.54	22.6	20.9
2			7.0	3.2	57.83	24.6	17.5
3			6.7	3.1	67.97	20.4	11.6
4	4.26	2.01	7.1	2.2	67.55	20.8	11.6
5			6.9	1.8	64.68	24.0	11.4
5aw	2.14	1.68					
6			6.5	2.7	56.93	26.6	16.5
8			6.4	3.1	54.69	27.9	17.4

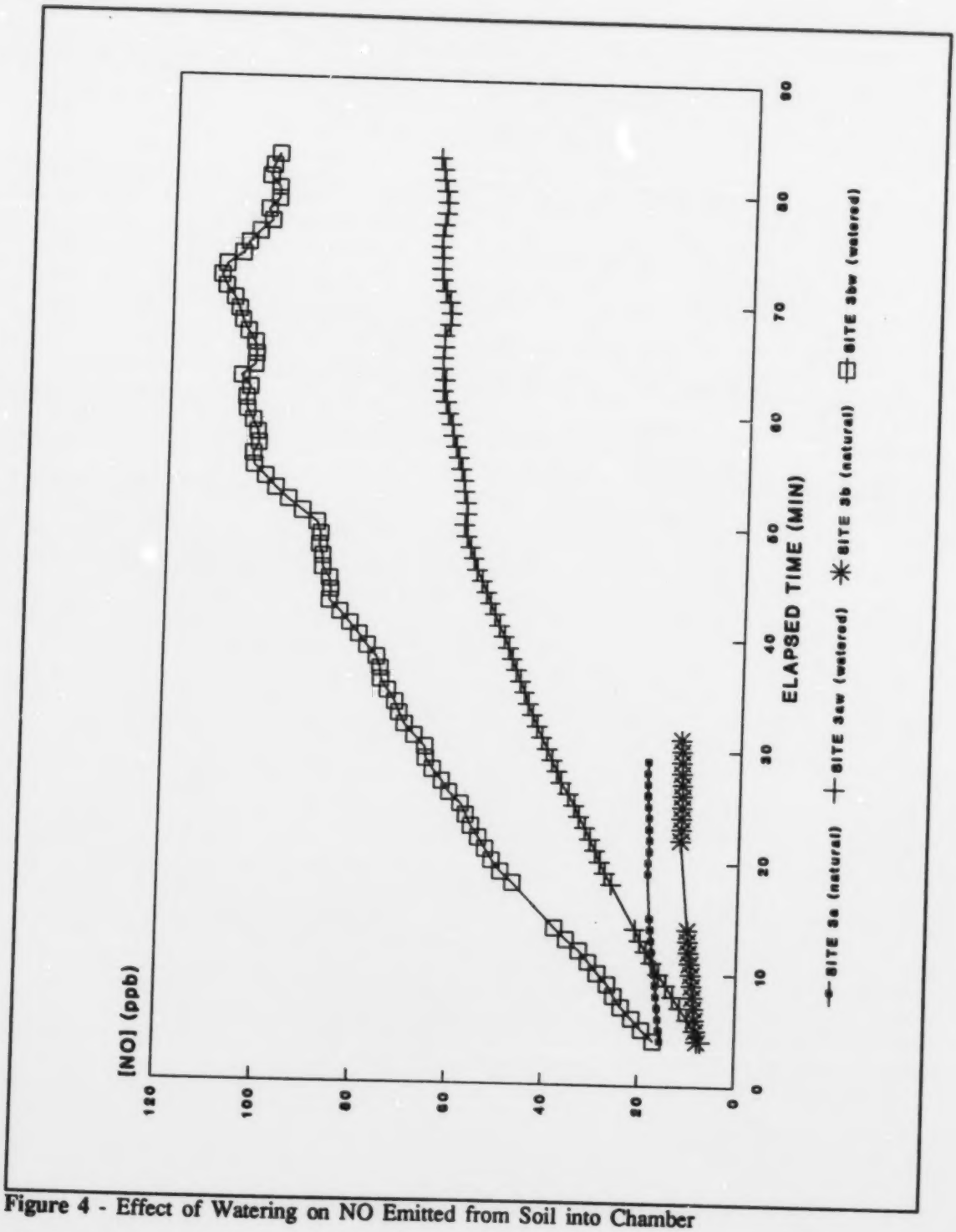


Figure 4 - Effect of Watering on NO Emitted from Soil into Chamber

relative humidity, absolute humidity, air-soil temperature difference, barometric pressure, soil free-pore volume and soil water content. All plots are given in Appendix D, only those plots where significant trends were observed are included in the main body of the report.

Figures 5 and 6 show the NO fluxes plotted against soil temperature. (Figure 6 does not incorporate data from watered replicates, but both figures contain the individual data points measured over the diurnal cycles). Diurnal data taken over the same plot yield the most obvious trends. In general, NO flux appeared to increase with soil temperature with peak values occurring between approximately 20 and 30 °C. The dramatic effect of soil watering can also be seen in Figure 5. (Figures D11-12 appear to indicate that the NO flux increased with soil moisture content, however, the data are very limited).

Data from the same plot for a diurnal cycle appear to confirm the dependence of flux on soil temperature (as measured inside the chamber). The NO flux increased steadily with soil temperature. The NO flux also tracked the soil temperature during its diurnal cycle extremely well, as illustrated in Figures 7A-B. Figures 8A-B show for comparison a plot of NO flux against chamber air temperature where a time lag between air temperature and NO flux can be clearly seen, presumably because the soil temperature adjusts more slowly and lags behind the air temperature.

Figures 9A-E illustrate the diurnal trends in NO flux, soil temperature, soil/air temperature difference, relative humidity and absolute humidity. Once again, the similarity between the diurnal trends in NO flux and soil temperature can be seen. A close correlation between NO flux and absolute humidity (which is temperature dependent) can also be seen. Figure 9C illustrates the lag between soil and air temperature.

Analysis of soil properties in Table 4 proved to be inconclusive in determining any relationship to NO flux. It would appear that the other factors discussed above played a more important role in determining NO flux during the present measurements.

NO flux values from this study ranged from 0.3 to 11.6 ng(N) $m^{-2}s^{-1}$ and were of similar order of magnitude to the results of others. Applicable reported results are shown in Table 5.

It would be desirable to use these flux values as input to model simulations to estimate the relative importance of natural emissions of NO from soils to O_3 levels in Ontario, particularly during the growing season. One-dimensional chemical kinetic models suitable for this purpose are presently being implemented at Ontario Hydro.

4.0 CONCLUDING REMARKS

This report documents measurements of natural NO_x emissions from soils made at CARE, Egbert, Ontario from July to September, 1989 using a flow-through chamber technique. The following results were obtained:

1. NO emission fluxes ranged from 0.3 to 11.6 ng(N) $m^{-2}s^{-1}$ in reasonable accord with values measured in Europe, the USA and Australia (0.08 to 21 ng(N) $m^{-2}s^{-1}$ for unfertilized field or pasture).

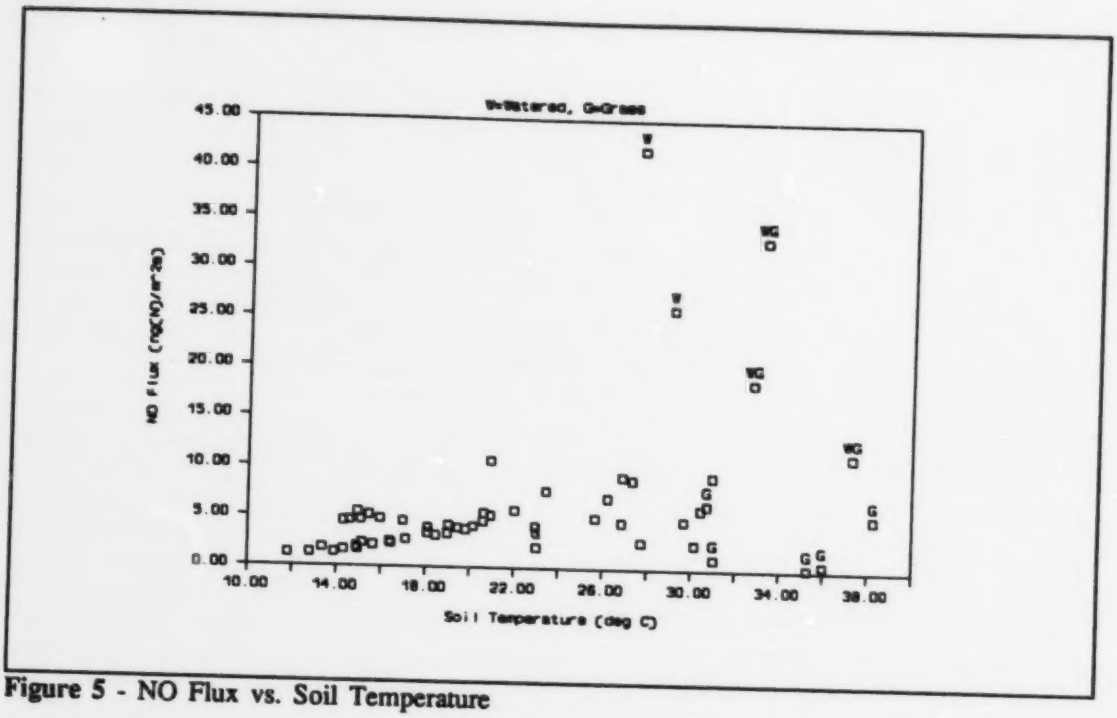


Figure 5 - NO Flux vs. Soil Temperature

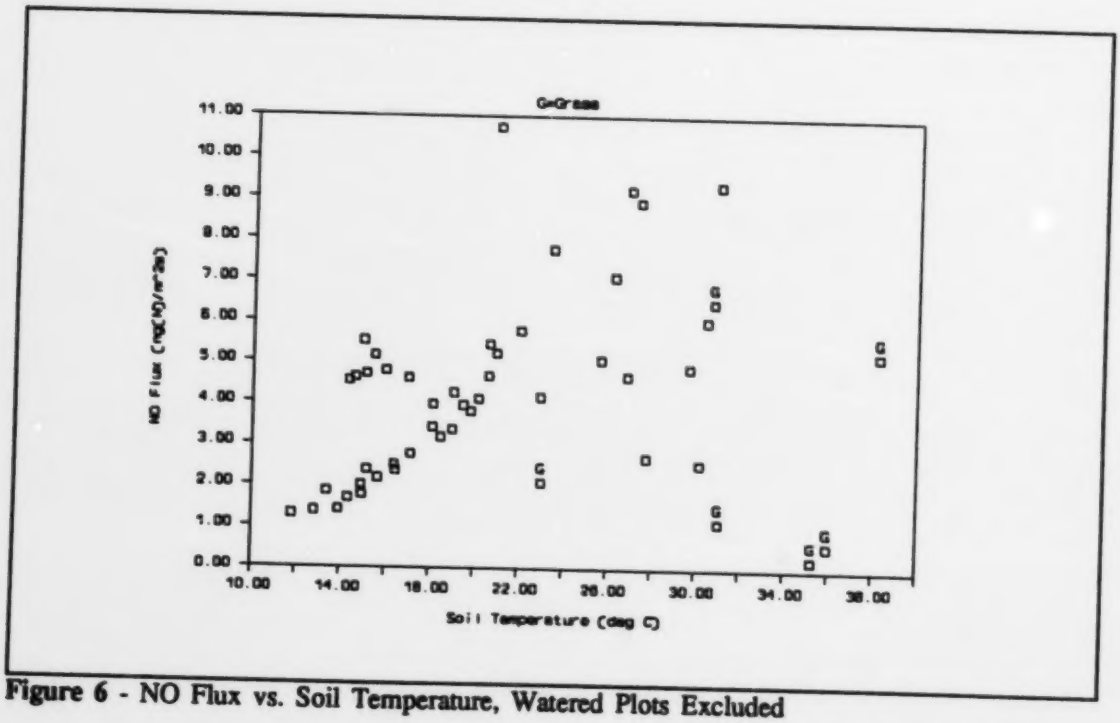


Figure 6 - NO Flux vs. Soil Temperature, Watered Plots Excluded

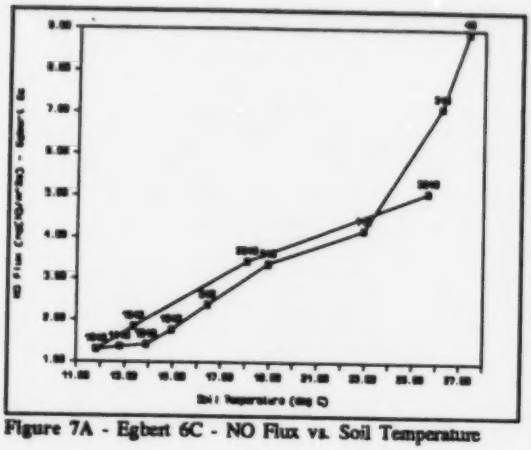


Figure 7A - Egbert 6C - NO Flux vs. Soil Temperature

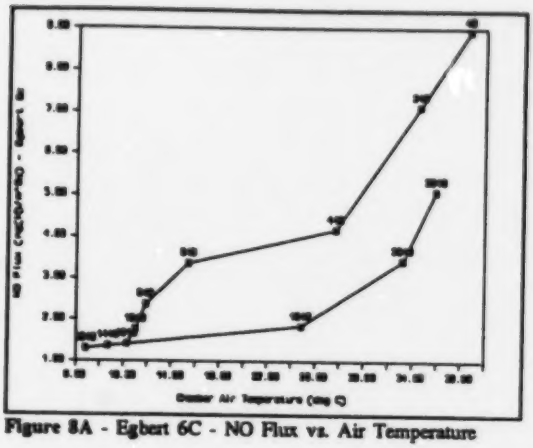


Figure 8A - Egbert 6C - NO Flux vs. Air Temperature

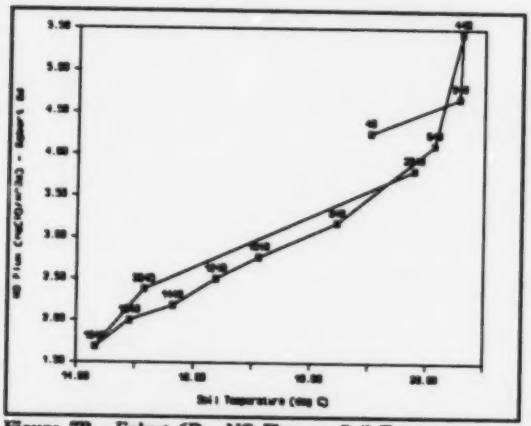


Figure 7B - Egbert 6D - NO Flux vs. Soil Temperature

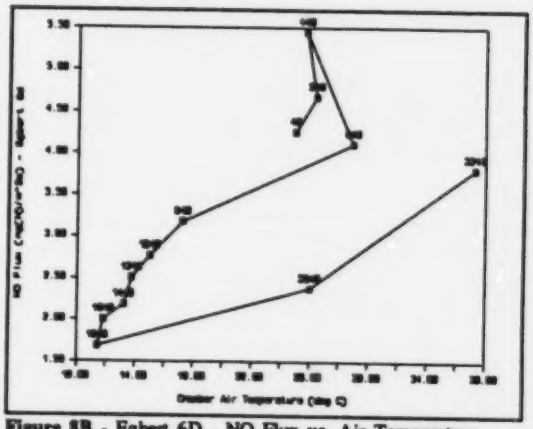


Figure 8B - Egbert 6D - NO Flux vs. Air Temperature

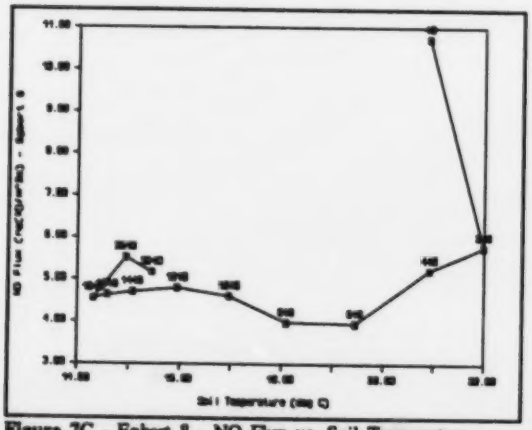


Figure 7C - Egbert 8 - NO Flux vs. Soil Temperature

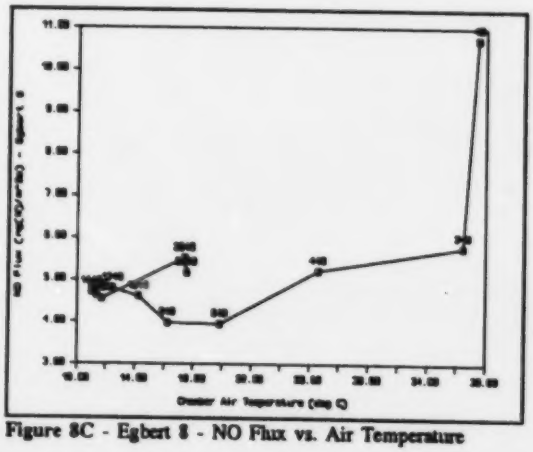
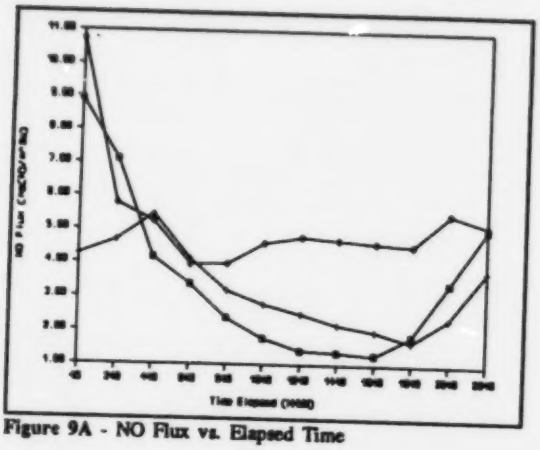


Figure 8C - Egbert 8 - NO Flux vs. Air Temperature



= Egbert 6c
= Egbert 6d
= Egbert 8

Figure 9A - NO Flux vs. Elapsed Time

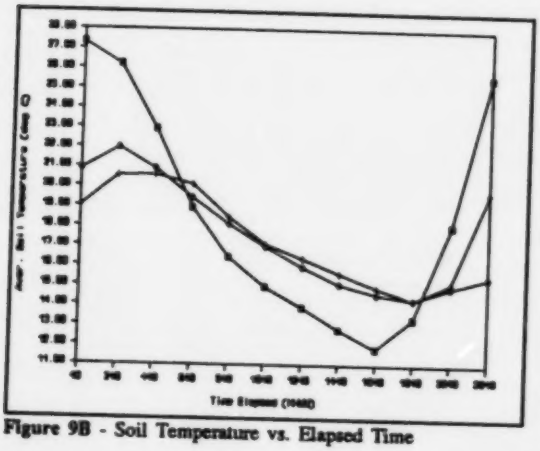


Figure 9B - Soil Temperature vs. Elapsed Time

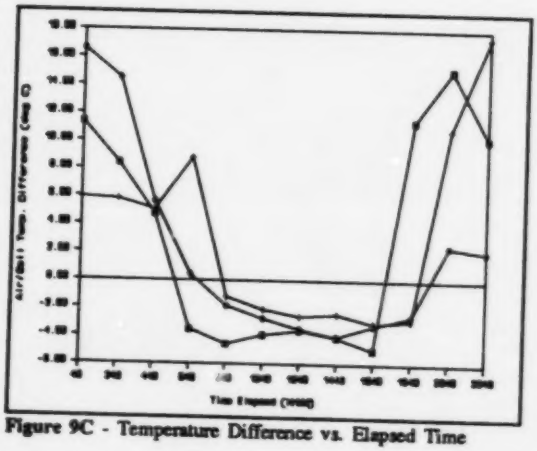


Figure 9C - Temperature Difference vs. Elapsed Time

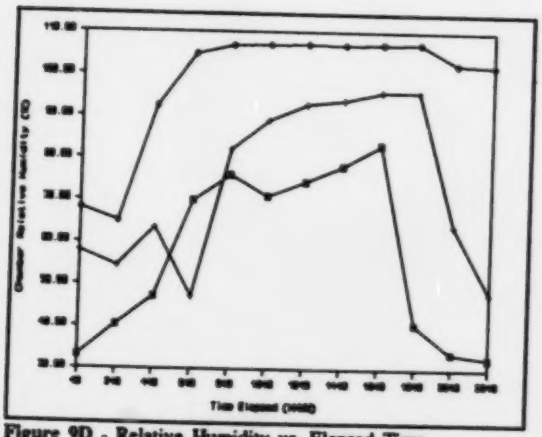


Figure 9D - Relative Humidity vs. Elapsed Time

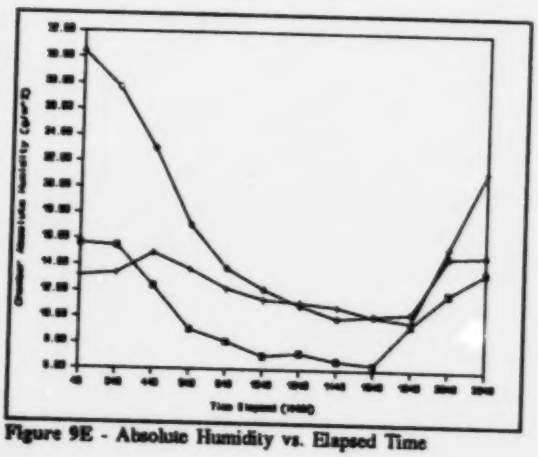


Figure 9E - Absolute Humidity vs. Elapsed Time

Table 5 - NO Flux Results From Other Studies

NO Flux ($ng(N)\ m^{-2}s^{-1}$)	Reference	Field Type	Time of Year
0.91-2.7	MacKay & Ogram, 1989 (Canada)	unfert. agricultural field	Aug. to Sep.
1.7	Anderson & Levine, 1987 (U.S.A.)	unfert. agricultural field	full year
3.5	Galbally & Roy, 1978 (Australia)	grazed pasture	spring, fall
1.6	" " "	ungrazed pasture	" "
<17	Johansson & Granat, 1984 (Sweden)	unfert. agricultural field	April, July
0.08-21	Parish et al, 1987 (U.S.A.)	unfertilized, uncultivated, ungrazed pasture	Aug. to Oct. at night
3.0	Williams et al, 1987 (U.S.A.)	" " "	Aug.-Nov.
2.2	Slemr & Seiler, 1984 (FRG, SPA)	bare, unfertilized field	

2. NO_2 fluxes were generally too small to be detected reliably.

3. NO fluxes were higher over a soil with mixed grass and alfalfa cover, than over an adjacent drier soil with grass cover.

4. NO fluxes from adjacent plots (30 cm x 30 cm) located one to three metres apart varied significantly (by a factor of approximately four). However, average values obtained from groups of two or three adjacent plots, each group located approximately 10 m apart on the alfalfa field, were in good agreement. The two grassed sites showed greater variability, perhaps due to different soil water content.

5. NO emission fluxes showed a strong diurnal variation and appeared to depend on soil temperature.

6. Application of water to the experimental plots to simulate rainfall increased the NO emission fluxes greatly (by an average factor of 5.4).

Further studies are planned at Egbert through July, 1990, to investigate the effect of season on NO_x emission rates. Field experiments will also be carried out at one or two other sites to supply data for comparison with the laboratory measurements being conducted by the Biological Research Section of Ontario Hydro using soil samples from various sites representative of southern Ontario with the intent of mapping regional NO emission patterns.

ACKNOWLEDGEMENTS

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APPENDIX A

SOIL NO, EMISSION FLUX MEASUREMENTS AT EGBERT, ONTARIO, JULY TO SEPTEMBER, 1989 - EXPERIMENTAL DATA

Table A1 - EGBERT SOURCE DATA (Site 1a - July 10, 1989 - Alfalfa)

TIME	STATUS	NOx (ppb)	COMMENTS
1359	NO2	0.364	ambient
1400	NO2	0.381	ambient
1401	NOx	0.513	ambient
1402	NOx	0.58	ambient
1403	NO2	0.412	ambient
1404	NO2	0.389	ambient
1405	NOx	0.493	ambient
1406	NOx	0.58	ambient
1409	NO2	0.112	zero
1410	NO2	0.109	zero
1411	NOx	0.294	zero
1412	NOx	0.336	zero
1413	NO2	0.132	zero
1414	NO2	0.115	zero
1415	NOx	0.277	zero
1416	NOx	0.339	zero
1421	NO2	1.369	soil
1422	NO2	1.386	soil
1423	NOx	5.917	soil
1424	NOx	7.08	soil
1425	NOx	7.4	soil
1426	NOx	7.37	soil
1427	NOx	7.57	soil
1428	NOx	7.51	soil
1429	NOx	7.94	soil
1430	NOx	8.27	soil
1431	NOx	7.87	soil
1432	NOx	7.88	soil
1433	NOx	8.36	soil
1434	NOx	8.82	soil
1435	NO2	2.089	soil
1436	NO2	1.352	soil
1437	NOx	8.11	soil
1438	NOx	8.06	soil
1439	NOx	7.32	soil
1440	NOx	7.7	soil
1441	NOx	7.96	soil
1442	NOx	8.64	soil
1443	NOx	9.09	soil
1444	NOx	9.39	soil
1445	NOx	8.38	soil
1446	NOx	7.85	soil
1447	NOx	7.23	soil
1448	NOx	7.01	soil
1449	NO2	2.117	soil
1450	NO2	1.456	soil
1453	NO2	0.395	ambient
1454	NO2	0.372	ambient
1455	NOx	0.543	ambient
1456	NOx	0.552	ambient
1457	NO2	0.431	ambient
1458	NO2	0.37	ambient
1459	NOx	0.473	ambient
1500	NOx	0.512	ambient
1503	NO2	0.109	zero
1504	NO2	0.106	zero
1505	NOx	0.372	zero
1506	NOx	0.451	zero
1507	NO2	0.143	zero
1508	NO2	0.123	zero
1509	NOx	0.339	zero
1510	NOx	0.431	zero

Pre-run calibration achieved at 13.2 ppbv.

TIME	PANEL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	PRESSURE (mb)	RH (%)	AIR TEMP (C)
1400	36.28	28.3	31.11	30.35	1008	49.47	30.2
1405	36.82	28.55	31.41	30.67	1008	49.2	30.45
1410	37.32	28.8	31.76	31.11	1008	49.01	30.42
1415	37.01	28.65	31.66	30.92	1008	46.92	33.57
1420	36.96	28.48	31.68	30.99	1008	46.18	35.75
1425	36.9	28.33	31.42	31.09	1008	43.89	36.8
1430	37.21	28.46	31.65	31.38	1008	43.41	37.56
1435	37.87	28.56	31.9	31.16	1008	42.84	38.27
1440	37.65	28.76	32.21	30.67	1008	42.06	38.77
1445	37.69	28.44	32.49	31.35	1008	42.2	39.09
1450	37.41	28.07	32.24	31.52	1007	40.87	39.51
1455	37.28	28.02	32.13	31.67	1007	41.72	34.21
1500	37.69	28.2	32.09	32.04	1007	43.41	31.75
1505	37.7	28.11	31.73	32.02	1007	44.31	31.12
1510	37.48	28	31.6	31.94	1007	45.08	30.25

WEATHER:

TEMPERATURE: 28 C

WINDS: 20 KNOTS G 60 KNOTS AT 350

CLOUD COVERAGE: 3/10 Cu, 1/10 Cl half

TIME: 13:20

Table A2 - EGBERT SOURCE DATA (Site 1b - July 10, 1989 - Alfalfa)

TIME	STATUS	NOx (ppb)	COMMENTS
1539	NO2	0.252	ambient
1540	NO2	0.216	ambient
1541	NOx	0.344	ambient
1542	NOx	0.35	ambient
1543	NO2	0.241	ambient
1544	NO2	0.244	ambient
1545	NOx	0.344	ambient
1546	NOx	0.37	ambient
1549	NO2	-0.02	zero
1550	NO2	-0.045	zero
1551	NOx	0.232	zero
1552	NOx	0.325	zero
1553	NO2	0.034	zero
1554	NO2	-0.022	zero
1555	NOx	0.196	zero
1556	NOx	0.238	zero
1600	NO2	0.482	soil
1601	NO2	0.451	soil
1602	NOx	7.92	soil
1603	NOx	10.09	soil
1604	NOx	10.57	soil
1605	NOx	10.57	soil
1606	NOx	10.31	soil
1607	NOx	10.27	soil
1608	NOx	10.86	soil
1609	NOx	11.11	soil
1610	NOx	11.08	soil
1611	NOx	11.18	soil
1612	NOx	11.86	soil
1613	NOx	11.78	soil
1614	NO2	1.859	soil
1615	NO2	0.93	soil
1616	NOx	9.66	soil
1617	NOx	11.73	soil
1618	NOx	12.31	soil
1619	NOx	13.05	soil
1620	NOx	13.41	soil
1621	NOx	12.61	soil
1622	NOx	12.93	soil
1623	NOx	13.7	soil
1624	NOx	14.28	soil
1625	NOx	14.69	soil
1626	NOx	15.25	soil
1627	NOx	14.43	soil
1628		2.898	soil
1629	NO2	0.899	soil
1632	NO2	0.213	ambient
1633	NO2	0.202	ambient
1634	NOx	0.37	ambient
1635	NOx	0.375	ambient
1636	NO2	0.263	ambient
1637	NO2	0.202	ambient
1638	NOx	0.311	ambient
1639	NOx	0.364	ambient
1642	NO2	-0.067	zero
1643	NO2	-0.067	zero
1644	NOx	0.129	zero
1645	NOx	0.168	zero
1646	NO2	-0.042	zero
1647	NO2	-0.067	zero
1648	NOx	0.151	zero
1649	NOx	0.204	zero

TIME	PANEL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	PRESSURE (mb)	RH (%)	AIR TEMP (C)
1540	35.58	25.61	29.98	24.61	1006	46.07	29.24
1545	35.66	25.73	30.04	24.51	1006	45.52	29.37
1550	36.63	25.93	30.38	24.5	1006	44.76	29.83
1555	35.91	26.04	30.24	24.26	1006	45.61	29.11
1600	36.18	26.08	30.5	24.05	1006	40.05	33.4
1605	36.45	26.34	31.28	24.14	1006	39.09	35.98
1610	36.13	26.35	31.37	24.07	1006	38.54	37.14
1615	35.94	26.38	31.36	24.03	1006	38.39	37.83
1620	36.21	26.47	31.28	24.1	1006	38.37	38.44
1625	36.72	26.44	31.29	24.12	1006	38.25	39.05
1630	36.69	26.55	31.46	24.15	1006	37.37	39.28
1635	36.06	26.58	30.86	24.03	1006	36.73	32.13
1640	35.67	26.72	30.44	24.06	1006	38.9	30.79
1645	35.87	26.61	30.05	24.07	1006	39.56	30.78

WEATHER:

TEMPERATURE: 28 C

WINDS: 30 KNOTS G 50 KNOTS AT 355

CLOUD COVERAGE: 2/10 Cu, 1/10 Ci

TIME: 15:55

Table A3 - EGBERT SOURCE DATA (Site 1c - July 10, 1989 - Alfalfa)

TIME	STATUS	NOx (ppb)	COMMENTS
1716	NO2	0.143	ambient
1717	NO2	0.191	ambient
1718	NOx	0.255	ambient
1719	NOx	0.261	ambient
1720	NO2	0.191	ambient
1721	NO2	0.168	ambient
1722	NOx	0.272	ambient
1723	NOx	0.3	ambient
1725	NO2	-0.137	zero
1726	NO2	-0.134	zero
1727	NOx	-0.064	zero
1728	NOx	-0.039	zero
1733	NO2	1.216	soil
1734	NO2	1.096	soil
1735	NOx	18.14	soil
1736	NOx	21.51	soil
1737	NOx	21.79	soil
1738	NOx	22.25	soil
1739	NOx	23.18	soil
1740	NOx	23.29	soil
1741	NOx	22.56	soil
1742	NOx	21.28	soil
1743	NOx	21.22	soil
1744	NOx	20.52	soil
1745	NOx	19.96	soil
1746	NOx	19.95	soil
1747	NO2	3.78	soil
1748	NO2	1.648	soil
1749	NOx	18.65	soil
1750	NOx	22.26	soil
1751	NOx	22.2	soil
1752	NOx	22.71	soil
1753	NOx	23.91	soil
1754	NOx	24.92	soil
1755	NOx	25.95	soil
1756	NOx	25.3	soil
1757	NOx	25.6	soil
1758	NOx	24.79	soil
1759	NOx	24.43	soil
1800	NOx	25.64	soil
1801	NO2	3.783	soil
1802	NO2	0.936	soil
1803	NO2	1.096	soil
1806	NO2	0.269	ambient
1807	NO2	0.216	ambient
1808	NOx	0.462	ambient
1809	NOx	0.373	ambient

TIME	PANEL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	PRESSURE (mb)	RH (%)	AIR TEMP (C)
1720	33.3	27.97	30.57	27.24	1006	45.36	28.09
1725	33.32	27.81	30.5	27.19	1006	45.88	27.9
1730	32.96	27.49	30.33	27.02	1006	45.63	29.84
1735	33.02	27.03	29.96	26.73	1005	50.5	32.1
1740	32.75	26.75	29.78	26.65	1005	50.91	32.8
1745	32.25	26.45	29.61	26.57	1006	50.24	33.06
1750	31.84	26.23	29.48	26.5	1005	50.82	33.14
1755	31.61	26.16	29.45	26.47	1005	51.95	33.11
1800	31.64	26.07	29.42	26.44	1005	52.03	33.16
1805	31.67	26.03	29.38	26.45	1005	49.42	31.91
1810	31.17	25.9	29.18	26.38	1005	43.46	29.09

WEATHER:

TEMPERATURE: 27 C

WINDS: 30 KNOTS G 55 KNOTS AT 350

CLOUD COVERAGE: 1/10 Cu, 2/10 Ci

VISIBILITY: 16 km

TIME: 17:17

Table A4 - EGBERT SOURCE DATA (Site 2a - July 11, 1989 - Alfalfa)

TIME	STATUS	NOx (ppb)	COMMENTS
1235	NO2	0.171	ambient
1236	NO2	0.171	ambient
1237	NOx	0.35	ambient
1238	NOx	0.364	ambient
1239	NO2	0.182	ambient
1240	NO2	0.176	ambient
1241	NOx	0.322	ambient
1242	NOx	0.375	ambient
1245	NO2	0.031	zero
1246	NO2	0.031	zero
1247	NOx	0.347	zero
1248	NOx	0.392	zero
1249	NO2	0.045	zero
1250	NO2	0.008	zero
1251	NO2	0.048	zero
1252	NO2	0.003	zero
1253	NOx	0.3	zero
1254	NOx	0.437	zero
1257	NO2	0.339	soil
1258	NO2	0.283	soil
1259	NOx	20.41	soil
1300	NOx	22.53	soil
1301	NOx	22.49	soil
1302	NOx	22.74	soil
1303	NOx	23.11	soil
1304	NOx	23.08	soil
1305	NOx	22.42	soil
1306	NOx	22.32	soil
1307	NOx	22.41	soil
1308	NOx	22.29	soil
1309	NOx	22.61	soil
1310	NOx	23.12	soil
1311	NO2	2.279	soil
1312	NO2	0.258	soil
1313	NOx	21.56	soil
1314	NOx	23.78	soil
1315	NOx	23.8	soil
1316	NOx	23.96	soil
1317	NOx	24.15	soil
1318	NOx	24.63	soil
1319	NOx	24.9	soil
1320	NOx	25.25	soil
1321	NOx	25.59	soil
1322	NOx	25.54	soil
1323	NOx	25.47	soil
1324	NOx	25.42	soil
1325	NO2	1.876	soil
1326	NO2	0.297	soil
1328	NO2	0.199	ambient
1329	NO2	0.157	ambient
1330	NOx	0.347	ambient
1331	NOx	0.336	ambient
1332	NO2	0.21	ambient
1333	NO2	0.171	ambient
1334	NOx	0.327	ambient
1335	NOx	0.333	ambient
1337	NO2	0	zero
1338	NO2	0.025	zero
1339	NOx	0.291	zero
1340	NOx	0.336	zero
1341	NO2	0.076	zero
1342	NO2	0.045	zero
1343	NOx	0.305	zero
1344	NOx	0.305	zero

Pre-run calibration achieved at 13.2 ppbv.
Post-run calibration achieved at 12.95 ppbv.

TIME	PANEL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	PRESSURE (mb)	RH (%)	AIR TEMP (C)
1235	36.7	26.92	29.3	34.58	998	37.06	28.23
1240	37.6	27.32	29.73	34.87	998	36.8	28.19
1245	37.71	27.34	29.81	34.77	998	37.09	28.27
1250	38.08	27.34	30.08	35.29	998	43.51	31.95
1255	36.32	26.79	29.97	35.04	998	46.27	33.53
1300	34.73	26.45	30.21	35.22	998	44.71	34.52
1305	33.64	26.27	30.39	35.23	998	44.13	34.99
1310	33.01	25.98	30.34	35.58	998	43.91	35.36
1315	32.54	25.83	30.37	35.63	998	43.84	35.79
1320	33.65	25.84	30.9	36.71	998	43.47	36.38
1325	38.22	25.98	31.59	37.44	998	42.87	37.04
1330	39.91	25.73	31.46	37.1	998	32.86	33.29
1335	40.78	25.47	31.21	36.86	998	32.45	29.44
1340	41.24	25.15	31.06	36.78	998	33.65	28.63

WEATHER:

TEMPERATURE: 26 C

WINDS: 20 KNOTS G 40 KNOTS AT 340

CLOUD COVERAGE: 2/10 Cu, 1/10 Ci

VISIBILITY: 16 km

Table A5 - EGBERT SOURCE DATA (Site 2b - July 11, 1989 - Alfalfa)

TIME	STATUS	NOx (ppb)	COMMENTS
1406	NO2	0.456	ambient
1407	NO2	0.47	ambient
1408	NOx	0.764	ambient
1409	NOx	0.829	ambient
1410	NO2	0.501	ambient
1411	NO2	0.436	ambient
1412	NOx	0.778	ambient
1413	NOx	0.851	ambient
1415	NO2	-0.039	zero
1416	NO2	-0.067	zero
1417	NOx	0.126	zero
1418	NOx	0.196	zero
1419	NO2	0.011	zero
1420	NO2	-0.031	zero
1421	NOx	0.129	zero
1422	NOx	0.196	zero
1427	NO2	0.252	soil
1428	NO2	0.266	soil
1429	NOx	4.202	soil
1430	NOx	5.333	soil
1431	NOx	6.037	soil
1432	NOx	6.76	soil
1433	NOx	7.27	soil
1434	NOx	7.28	soil
1435	NOx	7.32	soil
1436	NOx	7.34	soil
1437	NOx	7	soil
1438	NOx	6.91	soil
1439	NOx	6.613	soil
1440	NOx	6.591	soil
1441	NO2	0.874	soil
1442	NO2	0.261	soil
1443	NOx	6.773	soil
1444	NOx	7.84	soil
1445	NOx	7.67	soil
1446	NOx	7.42	soil
1447	NOx	7.39	soil
1448	NOx	7.69	soil
1449	NOx	7.85	soil
1450	NOx	7.65	soil
1451	NOx	7.38	soil
1452	NOx	6.949	soil
1453	NOx	6.879	soil
1454	NOx	7.01	soil
1455	NO2	0.928	soil
1456	NO2	0.303	soil
1458	NO2	0.49	ambient
1459	NO2	0.314	ambient
1501	NOx	0.513	ambient
1502	NOx	0.443	ambient
1503	NOx	0.518	ambient
1504	NO2	0.325	ambient
1505	NO2	0.252	ambient
1506	NOx	0.488	ambient
1507	NOx	0.516	ambient
1509	NO2	-0.036	zero
1510	NO2	-0.081	zero
1511	NOx	0.121	zero
1512	NOx	0.129	zero
1513	NO2	-0.056	zero
1514	NO2	-0.059	zero
1515	NOx	0.112	zero
1516	NOx	0.149	zero

TIME	PANEL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	PRESSURE (mb)	RH (%)	AIR TEMP (C)
1410	33.8	28.35	28.02	28.77	998	34.97	26.56
1415	33.08	27.85	28.19	28.82	998	35.17	26.5
1420	32.58	27.25	28.32	28.93	997	34.28	26.35
1425	31.99	26.66	28.41	29.01	998	34.32	26.57
1430	31.5	26.27	28.65	29.2	998	37.61	30.31
1435	31.1	25.92	28.93	29.6	997	39.59	32.1
1440	30.62	25.62	29.18	29.93	998	39.05	33.22
1445	30.98	25.3	29.3	30.12	997	39.52	34.02
1450	30.92	25.03	29.42	30.26	998	38.99	34.72
1455	30.67	24.71	29.5	30.38	998	38.16	35.2
1500	30.74	24.45	29.63	30.53	998	29.83	32.26
1505	30.9	24.31	29.73	30.55	998	27.52	28.37
1510	30.81	24.18	29.69	30.41	998	29.23	27.24
1515	30.72	24.07	29.61	30.29	998	29.45	26.88

WEATHER:

TEMPERATURE: 27 C

WINDS: 25 KNOTS G 30 KNOTS AT 320

CLOUD COVERAGE: 1/10 Cu, 1/10 Ci

VISIBILITY: 16 km

Table A6 - EGBERT SOURCE DATA (Site 2c - July 11, 1989 - Alfalfa)

TIME	STATUS	NOx (ppb)	COMMENTS
1531	NO2	0.216	ambient
1532	NO2	0.191	ambient
1533	NOx	0.353	ambient
1534	NOx	0.345	ambient
1535	NO2	0.224	ambient
1536	NO2	0.282	ambient
1537	NOx	0.292	ambient
1538	NOx	0.266	ambient
1540	NO2	-0.031	zero
1541	NO2	-0.003	zero
1542	NOx	0.146	zero
1543	NOx	0.207	zero
1544	NO2	0.042	zero
1546	NO2	0.516	soil
1547	NO2	0.437	soil
1548	NOx	11.56	soil
1549	NOx	13.91	soil
1550	NOx	14.82	soil
1551	NOx	15.43	soil
1552	NOx	15.92	soil
1553	NOx	16.35	soil
1554	NOx	16.65	soil
1555	NOx	17.21	soil
1556	NOx	17.86	soil
1557	NOx	18.42	soil
1558	NOx	18.21	soil
1559	NOx	17.42	soil
1600	NO2	1.806	soil
1601	NO2	0.656	soil
1602	NOx	14	soil
1603	NOx	15.83	soil
1604	NOx	15.71	soil
1605	NOx	16.04	soil
1606	NOx	16.7	soil
1607	NOx	16.89	soil
1608	NOx	17.4	soil
1609	NOx	17.87	soil
1610	NOx	16.8	soil
1611	NOx	16.2	soil
1612	NOx	16.89	soil
1615	NO2	-0.036	zero
1616	NO2	-0.062	zero
1617	NOx	0.191	zero
1618	NOx	0.115	zero

TIME	PANEL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	PRESSURE (mb)	RH (%)	AIR TEMP (C)
1535	29.08	26.03	32.41	35.19	997	29.6	26.04
1540	28.75	25.72	32.31	35.16	997	30.91	26.17
1545	28.47	25.29	32.05	35.96	997	35.43	30.81
1550	28.19	24.85	31.79	36.57	997	36.54	32.92
1555	27.99	24.62	31.51	36.99	997	36.85	34.3
1600	28.13	24.4	31.77	37.53	997	36.58	35.4
1605	27.88	24.1	31.53	37.4	997	35.77	36.09
1610	27.58	23.99	30.98	37.42	997	36.37	36.54
1615	27.24	23.78	30.31	37.28	997	35.84	36.89

WEATHER:

TEMPERATURE: 26 C

WINDS: 25 KNOTS G 40 KNOTS AT 340

CLOUD COVERAGE: 2/10 Ci

VISIBILITY: 16 km

TIME: 15:42

Table A7 - EGBERT SOURCE DATA (Site 3a - July 13, 1989 - Alfalfa)

TIME	STATUS	NOx (ppb)	COMMENTS
1143	NO?	0.37	ambient
1144	NO2	0.356	ambient
1145	NOx	0.626	ambient
1146	NOx	0.687	ambient
1147	NO2	0.415	ambient
1148	NO2	0.401	ambient
1149	NOx	0.718	ambient
1150	NOx	0.782	ambient
1153	NO2	-0.034	zero
1154	NO2	-0.028	zero
1155	NOx	0.53	zero
1156	NOx	0.53	zero
1157	NO2	0.014	zero
1158	NO2	-0.017	zero
1159	NOx	0.418	zero
1200	NOx	0.471	zero
1202	NO2	0.233	soil
1203	NO2	0.179	soil
1204	NOx	16.33	soil
1205	NOx	19.26	soil
1206	NOx	19.57	soil
1207	NOx	19.89	soil
1208	NOx	20.09	soil
1209	NOx	20.37	soil
1210	NOx	20.65	soil
1211	NOx	20.91	soil
1212	NOx	21.29	soil
1213	NOx	21.61	soil
1214	NOx	21.87	soil
1215	NOx	22.1	soil
1216	NOx	22.35	soil
1217	NO2	1.736	soil
1218	NO2	0.165	soil
1219	NOx	20.28	soil
1220	NOx	22.98	soil
1221	NOx	22.91	soil
1222	NOx	22.76	soil
1223	NOx	22.76	soil
1224	NOx	22.89	soil
1225	NOx	22.96	soil
1226	NOx	23.13	soil
1227	NOx	23.3	soil
1228	NOx	23.37	soil
1229	NOx	23.44	soil
1230	NOx	23.4	soil
1231	NO2	1.252	soil
1232	NO2	0.221	soil
1234	NO2	0.307	ambient
1235	NO2	0.307	ambient
1236	NOx	0.902	ambient
1237	NOx	0.851	ambient
1239	NO2	0.045	zero
1240	NO2	0.042	zero
1241	NOx	0.448	zero
1242	NOx	0.563	zero

Pre-run calibration achieved at 14.5 ppbv.

TIME	PANEL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	PRESSURE (mb)	RH (%)	AIR TEMP (C)
1145	29.17	22.68	21.15	21.98	1001	43.97	24.15
1150	30.18	22.56	21.17	21.94	1001	43.67	24.48
1155	31.23	22.6	21.33	21.99	1001	44.91	26.26
1200	31.02	22.78	21.58	22.17	1001	50.01	28.07
1205	30.18	22.72	21.69	22.23	1001	50.01	28.52
1210	30.78	22.64	21.82	22.28	1001	49.08	29.09
1215	33.28	23.01	22.37	22.7	1001	47.56	30.46
1220	35.91	23.62	22.89	23.18	1000	45.86	32.04
1225	36.2	23.62	22.98	23.44	1000	44.43	33.41
1230	38.28	24.73	24.08	24.43	1000	43.08	35.03
1235	37.83	24.8	23.96	24.34	1001	37.68	32.05
1240	37.18	24.72	23.93	24.29	1001	35.87	28.48

WEATHER:

TEMPERATURE: 22 C

WINDS: 15 KNOTS G 40 KNOTS AT 350

CLOUD COVERAGE: 7/10 Ac, 1/10 Cu

VISIBILITY: 16 km

TIME: 11:56

Table A8 - EGBERT SOURCE DATA (Site 3aw - July 13, 1989 - Alfalfa, Watered)

TIME	STATUS	NOx (ppb)	COMMENTS
1245	NO2	0.42	ambient
1246	NO2	0.437	ambient
1247	NOx	0.424	ambient
1248	NOx	0.452	ambient
1249	NO2	0.411	ambient
1250	NO2	0.336	ambient
1251	NOx	0.521	ambient
1252	NOx	0.546	ambient
1254	NO2	0.356	soil
1255	NO2	0.33	soil
1256	NOx	5.94	soil
1257	NOx	8.85	soil
1258	NOx	10.85	soil
1259	NOx	12.82	soil
1300	NOx	14.73	soil
1301	NOx	16.48	soil
1302	NOx	18.2	soil
1303	NOx	19.93	soil
1304	NOx	21.55	soil
1305	NOx	23	soil
1306	NOx	24.43	soil
1307	NOx	25.64	soil
1308	NO2	2.119	soil
1309	NO2	0.238	soil
1310	NOx	27.32	soil
1311	NOx	31.24	soil
1312	NOx	32.7	soil
1313	NOx	33.89	soil
1314	NOx	34.99	soil
1315	NOx	36.2	soil
1316	NOx	37.39	soil
1317	NOx	38.73	soil
1318	NOx	39.88	soil
1319	NOx	41.13	soil
1320	NOx	42.84	soil
1321	NOx	43.77	soil
1322	NOx	44.97	soil
1323	NOx	46.12	soil
1324	NOx	47.3	soil
1325	NOx	48.37	soil
1326	NOx	49.45	soil
1327	NOx	50.45	soil
1328	NOx	51.32	soil
1329	NOx	52.3	soil
1330	NOx	53.24	soil
1331	NOx	54.19	soil
1332	NOx	55.03	soil
1333	NOx	56.06	soil
1334	NOx	57.15	soil
1335	NOx	58.17	soil
1336	NOx	59.19	soil
1337	NOx	60.09	soil
1338	NOx	61.14	soil
1339	NOx	62.25	soil
1340	NOx	62.96	soil
1341	NOx	63.81	soil
1342	NOx	64.63	soil
1343	NOx	65.19	soil
1344	NOx	64.74	soil
1345	NOx	64.92	soil
1346	NOx	65.4	soil
1347	NOx	65.62	soil
1348	NOx	66.13	soil
1349	NOx	66.77	soil
1350	NOx	67.39	soil
1351	NOx	68.1	soil
1352	NOx	68.5	soil
1353	NOx	69.29	soil
1354	NOx	69.82	soil
1355	NOx	70.6	soil
1356	NOx	70.2	soil
1357	NOx	70.7	soil
1358	NOx	70.7	soil
1359	NOx	70.5	soil
1400	NOx	70.6	soil
1401	NOx	69.4	soil
1402	NOx	69.22	soil
1403	NOx	69.64	soil
1404	NOx	70.6	soil
1405	NOx	71.3	soil
1406	NOx	71.5	soil
1407	NOx	71.4	soil
1408	NOx	71.7	soil
1409	NOx	71.6	soil
1410	NOx	71.2	soil

TIME	PANEL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	PRESSURE (mb)	RH (%)	AIR TEMP (C)
1245	40.88	25.1	24.65	24.99	1001	36.39	28.59
1250	39.49	25.35	24.74	25.02	1001	36.56	27.38
1255	39.18	25.43	24.85	25.01	1001	49.12	28.37
1300	37.37	25.45	25.1	25.38	1001	70.9	32.15
1305	39.47	25.86	25.79	25.8	1001	67.97	34.63
1310	40.85	26.44	26.56	26.4	1001	67.33	35.45
1315	42.18	26.79	27.04	26.8	1001	66.6	36
1320	43.67	27.1	27.71	27.29	1001	65.29	36.68
1325	42.36	27.04	27.76	27.67	1001	64.24	37.16
1330	40.9	27.39	28.18	28.06	1001	63.01	37.53
1335	40.15	27.36	28.64	28.43	1001	61.89	37.81
1340	40.22	27.1	29.16	28.97	1001	60.94	38.16
1345	40	27.09	29.81	29.59	1001	60.44	38.31
1350	38.91	27.19	30.66	30.45	1001	60.39	38.29
1355	39.37	26.79	31.1	30.89	1001	60.54	38.3
1400	39.82	26.76	31.5	31.2	1001	60.16	38.34
1405	40.22	25.99	31.57	31.36	1002	60.35	38.18
1410	41.5	25.5	31.52	31.21	1002	60.33	38.18
1415	40.03	25.65	31.48	30.72	1002	60.49	38.06
1420	38.84	25.64	31.87	31.17	1002	55.8	37.63
1425	38.11	25.54	32.06	31.35	1001	29.2	31.09
1430	37.43	25.47	32.27	31.52	1002	30.57	29.41

WEATHER:

TEMPERATURE: 22 C

WINDS: 15 KNOTS G 45 KNOTS AT 350

CLOUD COVERAGE: 5/10 Ac, 1/10 Cu, 1/10 Ci

VISIBILITY: 16 km

TIME: 12:46

TIME	STATUS	NOx (ppb)	COMMENTS
1411	NOx	70.8	soil
1412	NOx	70.6	soil
1413	NOx	70.9	soil
1414	NOx	71.4	soil
1415	NOx	71.7	soil
1416	NOx	72.2	soil
1417	NO2	6.717	soil
1418	NO2	0.238	soil
1419	NO2	0.235	soil
1421	NO2	0.344	ambient
1422	NO2	0.319	ambient
1423	NOx	0.875	ambient
1424	NOx	0.551	ambient
1427	NO2	0.042	zero
1428	NO2	0.034	zero
1429	NOx	0.364	zero
1430	NOx	0.493	zero

Table A9 - EGBERT SOURCE DATA (Site 3b - July 13, 1989 - Alfalfa)

TIME	STATUS	NOx (ppb)	COMMENTS
1442	NO2	0.176	ambient
1443	NO2	0.165	ambient
1444	NOx	0.339	ambient
1445	NOx	0.456	ambient
1446	NO2	0.238	ambient
1447	NO2	0.221	ambient
1448	NOx	0.677	ambient
1449	NOx	0.899	ambient
1456	NO2	-0.031	zero
1457	NO2	-0.014	zero
1458	NOx	0.311	zero
1459	NOx	0.403	zero
1500	NO2	0.014	zero
1501	NO2	-0.048	zero
1502	NOx	0.397	zero
1503	NOx	0.431	zero
1504	NOx	0.671	zero
1505	NOx	0.283	zero
1507	NO2	0.204	soil
1508	NO2	0.148	soil
1509	NOx	8.19	soil
1510	NOx	9.85	soil
1511	NOx	10.41	soil
1512	NOx	10.77	soil
1513	NOx	11.08	soil
1514	NOx	11.49	soil
1515	NOx	11.78	soil
1516	NOx	12.14	soil
1517	NOx	12.46	soil
1518	NOx	12.84	soil
1519	NOx	13.13	soil
1520	NOx	13.3	soil
1525	NO2	1.29	soil
1526	NO2	0.235	soil
1527	NOx	13.33	soil
1528	NOx	15.35	soil
1529	NOx	15.19	soil
1530	NOx	15.31	soil
1531	NOx	15.21	soil
1532	NOx	15.22	soil
1533	NOx	15.22	soil
1534	NOx	15.41	soil
1535	NOx	15.43	soil
1536	NOx	15.49	soil
1537	NOx	15.69	soil
1538	NO2	1.422	soil
1539	NO2	0.137	soil
1541	NO2	0.215	ambient
1542	NO2	0.204	ambient
1543	NOx	1.682	ambient
1544	NOx	0.775	ambient
1545	NO2	0.249	ambient
1546	NO2	0.196	ambient
1547	NOx	0.395	ambient
1549	NOx	0.143	zero
1550	NOx	0.218	zero
1551	NO2	-0.036	zero
1552	NO2	-0.078	zero

TIME	PANEL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	PRESSURE (mb)	RH(%)	AIR TEMP (C)
1445	41.14	28.35	32.2	26.32	1001	33.11	27.91
1450	41.6	28.26	32.75	26.63	1001	33.21	27.87
1455	41.71	28.08	33.07	26.75	1001	33.74	27.25
1500	41.49	27.74	33.23	26.93	1001	33.91	27.13
1505	41.34	27.78	33.88	27.21	1001	33.55	31.73
1510	40.82	27.6	34.33	27.22	1001	38.09	33.89
1515	39.11	27.31	34.47	27.23	1001	37.77	35.4
1520	38.25	27.51	35.32	27.88	1001	37.74	36.55
1525	38.15	26.67	34.94	27.3	1002	37.74	37.46
1530	37.46	27.31	35.71	27.86	1002	37.69	38.12
1535	38.88	26.83	35.63	27.53	1002	37.77	38.54
1540	39.7	26.91	35.71	27.64	1002	36.44	38.27
1545	37.11	26.52	35.82	27.69	1002	29.65	30.86
1550	34.94	26.1	34.35	27.78	1002	32.29	29.1

WEATHER:

TEMPERATURE: 24 C

WINDS: 20 KNOTS G 45 KNOTS AT 320

CLOUD COVERAGE: 2/10 Cu. 2/10 Ci

VISIBILITY: 16 km

TIME: 14:44

Table A10 - EGBERT SOURCE DATA (Site 3bw - July 13, 1989 - Alfalfa, Watered)

TIME	STATUS	NOx (ppb)	COMMENTS
1646	NOx	93.2	soil
1647	NOx	96	soil
1648	NOx	99	soil
1649	NOx	102	soil
1650	NOx	104.6	soil
1651	NOx	106.8	soil
1652	NOx	109.1	soil
1653	NOx	109.4	soil
1654	NOx	108.3	soil
1655	NOx	108.6	soil
1656	NOx	109.6	soil
1657	NOx	110.9	soil
1658	NOx	111.1	soil
1659	NOx	110.4	soil
1700	NOx	112.2	soil
1701	NOx	109.5	soil
1702	NOx	109.3	soil
1703	NOx	109.6	soil
1704	NOx	111.1	soil
1705	NOx	112.3	soil
1706	NOx	113	soil
1707	NOx	114	soil
1708	NOx	115.7	soil
1709	NOx	116.7	soil
1710	NOx	115.7	soil
1711	NOx	112.6	soil
1712	NOx	111.4	soil
1713	NOx	109.2	soil
1714	NOx	106.8	soil
1715	NOx	107.6	soil
1716	NOx	105.5	soil
1717	NOx	105.5	soil
1718	NOx	107.4	soil
1719	NOx	106.8	soil
1720	NOx	105.6	soil
1721	NOx	103.7	soil
1722	NO2	5.914	soil
1723	NO2	0.762	soil
1724	NO2	0.597	soil
1725	NO2	0.692	soil
1726	NO2	0.97	soil
1727	NO2	0.732	soil
1728	NO2	0.446	soil
1729	NO2	0.306	soil
1730	NO2	0.606	soil
1731	NO2	0.636	soil
1732	NO2	0.569	soil
1733	NO2	0.306	soil
1734	NO2	0.193	soil

WEATHER:

TEMPERATURE: 23 C

WINDS: 20 KNOTS G 45 KNOTS AT 350

CLOUD COVERAGE: 2/10 Cu, 3/10 Cl

VISIBILITY: 16 km

TIME: 17:12

Table A11 - EGBERT SOURCE DATA (Site 4a - July 18, 1989 - Grass)

TIME	STATUS	NOx (ppb)	COMMENTS
1145	NO2	0.581	ambient
1146	NO2	0.558	ambient
1147	NOx	1.256	ambient
1148	NOx	1.394	ambient
1149	NO2	0.681	ambient
1150	NO2	0.586	ambient
1151	NOx	1.127	ambient
1152	NOx	1.178	ambient
1154	NO2	0.025	zero
1155	NO2	0.028	zero
1156	NOx	0.376	zero
1157	NOx	0.423	zero
1158	NO2	0.09	zero
1159	NO2	0.081	zero
1200	NOx	0.3	zero
1201	NOx	0.334	zero
1203	NO2	0.575	soil
1204	NO2	0.533	soil
1205	NOx	1.621	soil
1206	NOx	1.924	soil
1207	NOx	2.055	soil
1208	NOx	2.17	soil
1209	NOx	2.333	soil
1210	NOx	2.512	soil
1211	NOx	2.664	soil
1212	NOx	2.807	soil
1213	NOx	2.908	soil
1214	NOx	3.011	soil
1215	NOx	3.061	soil
1216	NOx	3.061	soil
1217	NO2	0.737	soil
1218	NO2	0.505	soil
1219	NOx	2.683	soil
1220	NOx	2.91	soil
1221	NOx	2.949	soil
1222	NOx	2.941	soil
1223	NOx	2.952	soil
1224	NOx	3.011	soil
1225	NOx	3.067	soil
1226	NOx	3.143	soil
1227	NOx	3.235	soil
1228	NOx	3.305	soil
1229	NOx	3.389	soil
1230	NOx	3.476	soil
1231	NOx	3.504	soil
1232	NOx	3.538	soil
1233	NOx	3.532	soil
1234	NOx	3.521	soil
1235	NO2	0.911	soil
1236	NO2	0.572	soil
1238	NO2	0.74	ambient
1239	NO2	0.712	ambient
1240	NOx	1.099	ambient
1241	NOx	1.158	ambient
1242	NO2	0.757	ambient
1243	NO2	0.617	ambient
1244	NOx	0.981	ambient
1245	NOx	1.104	ambient
1247	NO2	0.174	zero
1248	NO2	0.154	zero
1249	NOx	0.469	zero
1250	NOx	0.42	zero
1251	NO2	0.221	zero
1252	NO2	0.224	zero
1253	NOx	0.412	zero
1254	NOx	0.44	zero

Pre-run calibration achieved at 13.95 ppbv.

TIME	PANEL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	PRESSURE (mb)	RH (%)	AIR TEMP (C)
1145	33.47	26.91	-	37.47	999	38.43	31.57
1150	34.06	26.75	-	39.48	999	36	31.91
1155	32.63	27.1	-	35.18	999	36.66	30.7
1200	32.56	27.29	-	34.69	1000	36.93	30.51
1205	31.54	27.2	-	32.71	1000	37.54	32.13
1210	34.23	27.55	34.77	-	999	37.02	34.66
1215	35.39	27.75	35.15	-	999	37.13	36.07
1220	33.24	27.95	34.78	30.72	999	38.34	35.92
1225	32.48	28.2	34.43	30.23	1000	39.29	35.82
1230	35.26	29	35.27	31.31	999	38.54	37.06
1235	34.86	29.02	35.09	30.92	999	39.29	37.08
1240	34.1	29.39	34.82	30.86	1000	34.94	34.13
1245	37.08	30.37	35.84	32.08	999	32.56	32.77
1250	37.24	30.4	35.9	32.11	999	34.3	32.29

WEATHER:

TEMPERATURE: 27 C

WINDS: 10 KNOTS G 30 KNOTS AT 245

CLOUD COVERAGE: 7/10 Cu, 1/10 Ci

VISIBILITY: 10 km
half

TIME: 11:54

Table A12 - EGBERT SOURCE DATA (Site 4b - July 18, 1989 - Grass)

TIME	STATUS	NOx (ppb)	COMMENTS
1259	NO2	0.737	ambient
1301	NOx	1.154	ambient
1302	NOx	1.259	ambient
1303	NO2	0.941	ambient
1304	NO2	0.768	ambient
1305	NOx	1.132	ambient
1306	NOx	1.154	ambient
1310	NO2	0.818	soil
1311	NO2	0.824	soil
1312	NOx	1.33	soil
1313	NOx	1.442	soil
1314	NOx	1.496	soil
1315	NOx	1.42	soil
1316	NOx	1.465	soil
1317	NOx	1.501	soil
1318	NOx	1.495	soil
1319	NOx	1.487	soil
1320	NOx	1.47	soil
1321	NOx	1.481	soil
1322	NOx	1.47	soil
1323	NOx	1.436	soil
1324	NOx	1.445	soil
1325	NO2	0.927	soil
1326	NO2	0.831	soil
1327	NOx	1.481	soil
1328	NOx	1.565	soil
1329	NOx	1.59	soil
1330	NOx	1.582	soil
1331	NOx	1.523	soil
1332	NOx	1.498	soil
1333	NOx	1.495	soil
1334	NOx	1.486	soil
1335	NOx	1.484	soil
1336	NOx	1.525	soil
1337	NOx	1.559	soil
1339	NO2	0.94	soil
1340	NO2	0.854	soil
1342	NO2	0.742	ambient
1343	NO2	0.789	ambient
1344	NOx	1.016	ambient
1345	NOx	1.103	ambient
1346	NO2	0.809	ambient
1347	NO2	0.775	ambient
1348	NOx	1.033	ambient
1349	NOx	1.024	ambient

TIME	PANEL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	PRESSURE (mb)	RH (%)	AIR TEMP (C)
1300	36.56	34.38	34.71	35.82	999	35.42	31.64
1305	38.44	34.53	34.51	35.26	999	33.97	32.47
1310	40.5	34.41	34.96	35.45	999	30.24	35.93
1315	41.06	34.44	35.27	35.87	999	27.93	39.14
1320	41.35	34.13	35.39	36.17	999	27.15	40.5
1325	41.24	34.26	35.59	36.49	999	26.39	41.33
1330	41.94	34	35.82	36.77	999	26.72	42.11
1335	41.36	34.26	36.01	37.04	1000	25.32	42.55
1340	41.45	34.21	36.3	37.34	1000	25.25	42.78
1345	41.18	33.72	36.24	37.42	1000	27.48	37.09

WEATHER:

TEMPERATURE: 29.5 C

WINDS: 15 KNOTS G 25 KNOTS AT 270

CLOUD COVERAGE: 7/10 Cu, 1/10 Ci

VISIBILITY: 10 km
half

TIME: 13:01

Table A13 - EGBERT SOURCE DATA (Site 4c - July 18, 1989 - Grass)

TIME	STATUS	NOx (ppb)	COMMENTS
1400	NO2	0.316	zero
1401	NO2	0.291	zero
1402	NOx	0.593	zero
1403	NOx	0.588	zero
1404	NO2	0.33	zero
1406	NOx	0.537	zero
1407	NOx	0.596	zero
1410	NO2	0.691	ambient
1411	NO2	0.697	ambient
1412	NOx	1.024	ambient
1413	NOx	1.088	ambient
1414	NO2	0.722	ambient
1415	NO2	0.688	ambient
1416	NOx	0.996	ambient
1417	NOx	1.01	ambient
1420	NO2	0.604	soil
1421	NO2	0.573	soil
1422	NOx	0.965	soil
1423	NOx	1.094	soil
1424	NOx	1.105	soil
1425	NOx	1.153	soil
1426	NOx	1.231	soil
1427	NOx	1.253	soil
1428	NOx	1.287	soil
1429	NOx	1.343	soil
1430	NOx	1.36	soil
1431	NOx	1.36	soil
1432	NOx	1.385	soil
1433	NOx	1.363	soil
1434	NOx	1.377	soil
1435	NO2	0.49	soil
1436	NO2	0.395	soil
1437	NOx	1.34	soil
1438	NOx	1.489	soil
1439	NOx	1.359	soil
1440	NOx	1.373	soil
1441	NOx	1.432	soil
1442	NOx	1.696	soil
1443	NOx	1.78	soil
1444	NOx	1.831	soil
1445	NOx	1.848	soil
1446	NOx	1.881	soil
1447	NOx	1.937	soil
1448	NOx	1.949	soil
1449	NOx	1.996	soil
1450	NOx	1.996	soil
1451	NOx	2.025	soil
1453	NO2	0.241	soil
1454	NO2	0.258	soil
1456	NO2	-0.031	zero
1457	NO2	-0.034	zero
1458	NO2	-0.05	zero
1459	NOx	0.101	zero
1500	NOx	0.115	zero
1501	NO2	-0.017	zero
1502	NO2	-0.073	zero
1503	NOx	0.104	zero
1504	NOx	0.146	zero
1506	NO2	0.51	ambient * tractor near site
1507	NO2	0.487	ambient - values for ambient air may be high
1508	NOx	0.781	ambient
1509	NOx	0.843	ambient
1510	NO2	0.504	ambient
1512	NOx	0.795	ambient
1513	NOx	0.821	ambient

TIME	PANEL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	PRESSURE (mb)	RH (%)	AIR TEMP (C)
1400	43.85	36.32	36.13	38.54	1000	29.26	34.83
1405	43.57	38.71	36.24	38.9	1000	28.74	34.77
1410	43.12	37.98	36	38.83	1000	28.57	34.5
1415	42.35	37.86	36.13	39.01	1000	30.32	33.85
1420	43.22	37.24	36.17	39.29	1000	29.16	35.64
1425	40.6	37.11	36.23	39.18	1000	28.68	39.17
1430	40.25	36.58	36.15	38.9	1000	30.09	40.45
1435	39.52	36.53	36.2	38.74	1000	31.34	40.42
1440	37.36	35.93	35.99	38.45	1000	33.14	40.09
1445	36.06	35.53	35.71	37.98	1000	35.13	39.4
1450	35.06	35.27	35.54	37.57	1000	36.63	38.86
1455	34.53	34.94	35.24	37.02	1000	37.41	38.64
1500	37.56	34.96	35.44	37.21	1000	31.66	35.09
1505	36.17	35	35.38	37.25	1000	33.36	31.85
1510	34.96	34.44	34.99	36.87	1000	34.16	31.38

WEATHER:

TEMPERATURE: 30.5 C

WINDS: 10 KNOTS G 25 KNOTS AT 240

CLOUD COVERAGE: 7/10 Cu, 1/10 Ci

VISIBILITY: 10 km
half

TIME: 14:07

Table A14 - EGBERT SOURCE DATA (Site 5a - July 21, 1989 - Grass)

TIME	STATUS	NOx (ppb)	COMMENTS
1223	NO2	1.631	ambient
1224	NO2	1.629	ambient
1225	NOx	1.605	ambient
1226	NOx	1.672	ambient
1227	NO2	1.133	ambient
1228	NO2	1.1	ambient
1229	NOx	1.694	ambient
1230	NOx	1.787	ambient
1232	NO2	0.042	zero
1233	NO2	0.045	zero
1234	NOx	0.358	zero
1235	NOx	0.561	zero
1236	NO2	0.098	zero
1237	NO2	0.053	zero
1238	NOx	0.376	zero
1239	NOx	0.457	zero
1241	NO2	0.693	soil
1242	NO2	0.784	soil
1243	NOx	4.196	soil
1244	NOx	4.979	soil
1245	NOx	5.018	soil
1246	NOx	5.119	soil
1247	NOx	5.29	soil
1248	NOx	5.537	soil
1249	NOx	5.955	soil
1250	NOx	6.031	soil
1251	NOx	5.978	soil
1252	NOx	6.093	soil
1253	NOx	6.283	soil
1254	NOx	6.376	soil
1255	NOx	6.244	soil
1256	NO2	1.327	soil
1257	NO2	0.872	soil
1258	NOx	5.434	soil
1259	NOx	6.174	soil
1300	NOx	6.426	soil
1301	NOx	6.71	soil
1302	NOx	6.847	soil
1303	NOx	7.06	soil
1304	NOx	7.21	soil
1305	NOx	7.19	soil
1306	NOx	7.22	soil
1307	NOx	7.36	soil
1308	NOx	7.17	soil
1309	NOx	7.07	soil
1310	NOx	7.06	soil
1311	NOx	7.11	soil
1312	NOx	7.25	soil
1313	NOx	7.46	soil
1314	NOx	7.58	soil
1315	NOx	7.74	soil
1316	NOx	7.9	soil
1317	NO2	1.56	soil
1318	NO2	0.794	soil

Pre-run calibration achieved at 13.7 ppbv.

TIME	PANEL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	PRESSURE (mb)	RH (%)	AIR TEMP (C)
1225	29.44	26.33	30.24	27.31	995	33.12	29.6
1230	29.07	26.43	30.21	27.34	995	32.03	29.83
1235	28.92	26.59	30.29	27.48	995	33.37	31.24
1240	28.83	26.77	30.42	27.64	995	37.82	33.47
1245	28.88	26.9	30.56	27.81	995	36.7	34.39
1250	29	27	30.73	28	995	35.18	35.26
1255	29.17	27.17	30.94	28.25	995	34.28	36.03
1300	29.14	27.32	31.08	28.43	995	34.26	36.41
1305	29.52	27.57	31.34	28.72	995	34.49	36.95
1310	29.73	27.75	31.57	28.96	995	33.5	37.63
1315	30.3	28.04	31.95	29.29	995	33.37	38.71

WEATHER:

TEMPERATURE: 25.5 C

WINDS: 20 KNOTS G 35 KNOTS AT 100

CLOUD COVERAGE: 5/10 STRATUS

VISIBILITY: 12 km

TIME: 12:33

Table A15 - EGBERT SOURCE DATA (Site 5aw - July 21, 1989 - Grass, Watered)

TIME	STATUS	NOx (ppb)	COMMENTS
1330	NO2	0.973	ambient
1331	NO2	0.967	ambient
1332	NOx	1.352	ambient
1333	NOx	1.435	ambient
1334	NO2	1.122	ambient
1335	NO2	1.08	ambient
1336	NOx	1.464	ambient
1337	NOx	2.05	ambient
1340	NO2	-0.006	zero
1341	NO2	-0.036	zero
1342	NOx	0.398	zero
1343	NOx	0.429	zero
1344	NO2	-0.014	zero
1345	NO2	-0.031	zero
1346	NOx	0.331	zero
1347	NOx	0.418	zero
1403	NO2	1.046	soil
1404	NO2	0.875	soil
1405	NOx	43.26	soil
1406	NOx	49.55	soil
1407	NOx	51.3	soil
1408	NOx	53.03	soil
1409	NOx	54.46	soil
1410	NOx	56.2	soil
1411	NOx	57.81	soil
1412	NOx	59.24	soil
1413	NOx	59.58	soil
1414	NOx	59.17	soil
1415	NOx	60.17	soil
1416	NOx	61.04	soil
1417	NO2	4.727	soil
1418	NO2	1.071	soil
1419	NOx	54.35	soil
1420	NOx	61.57	soil
1421	NOx	63.18	soil
1422	NOx	64.96	soil
1423	NOx	65.15	soil
1424	NOx	64.15	soil
1425	NOx	65.31	soil
1426	NOx	66.91	soil
1427	NOx	68.47	soil
1428	NOx	69.7	soil
1429	NOx	70.6	soil
1430	NOx	71.8	soil
1431	NOx	73.1	soil
1432	NOx	74.4	soil
1433	NOx	76.2	soil
1434	NOx	77.7	soil
1435	NOx	79	soil
1436	NOx	80.9	soil
1437	NOx	82.4	soil
1438	NOx	83.8	soil
1439	NOx	85.6	soil
1440	NOx	87.5	soil
1441	NO2	0.26	soil
1442	NO2	0.308	soil
1443	NOx	76.1	soil
1444	NOx	92.7	soil
1445	NOx	94.6	soil
1446	NOx	95	soil
1447	NOx	95.5	soil
1448	NOx	95.8	soil
1449	NOx	95.9	soil
1450	NOx	97.6	soil
1451	NOx	99.4	soil
1452	NOx	100.5	soil
1453	NOx	101.5	soil
1454	NOx	99.6	soil
1455	NOx	98.4	soil
1456	NOx	97.1	soil
1457	NO2	5.765	soil
1458	NO2	1.331	soil
1500	NO2	0.827	ambient
1501	NO2	0.74	ambient
1502	NO2	1.124	ambient
1503	NOx	1.483	ambient
1504	NOx	1.53	ambient
1506	NO2	-0.022	zero
1507	NO2	-0.05	zero
1508	NOx	0.49	zero
1509	NOx	0.577	zero

TIME	PANEL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	PRESSURE (mb)	RH (%)	AIR TEMP (C)
1330	31.05	29.11	32.85	30.37	995	28.34	33.48
1335	31.19	29.48	33.07	30.67	995	30.26	32.56
1340	31.48	29.8	33.29	31.05	995	31.13	32.32
1345	31.11	30.05	33.3	31.26	995	88.9	34.42
1350	31.19	30.07	33.54	31.59	995	92.2	36.65
1355	31.24	30.04	33.71	31.8	995	91.1	37.19
1400	31.54	30.03	33.93	32.06	995	90.2	37.97
1405	31.71	30.11	34.09	32.27	995	89.3	38.6
1410	32.39	30.13	34.36	32.58	995	87.9	39.73
1415	32.78	30.37	34.61	32.87	995	87.1	40.22
1420	32.68	30.56	34.69	33.11	995	86.9	40.43
1425	32.96	30.57	34.93	33.46	995	85.7	41.26
1430	33.28	30.6	35.18	33.79	995	85.5	41.82
1435	33.75	30.53	35.41	34.15	996	86	42.06
1440	33.96	30.77	35.55	34.42	996	86.9	42.12
1445	33.79	31.14	35.57	34.58	996	89	41.64
1450	33.62	30.79	35.49	34.74	996	88.3	41.94
1455	33.85	30.6	35.54	34.88	996	87.7	42.35
1500	33.36	30.57	35.52	34.93	996	88.95	41.03
1505	32.98	30.67	35.48	35.03	996	31.08	35.23
1510	32.88	30.36	35.36	35.1	996	33	34.11

WEATHER:

TEMPERATURE: 28 C

WINDS: 12 KNOTS G 20 KNOTS AT 120

CLOUD COVERAGE: 5/10 Ci

VISIBILITY: 12 km

Table A16 - EGBERT SOURCE DATA (Site 5b - August 1, 1989 - Grass)

TIME	STATUS	NOx (ppb)	COMMENTS
1115	NO2	1.457	ambient
1116	NO2	1.376	ambient
1117	NOx	1.062	ambient
1118	NOx	2.061	ambient
1119	NO2	1.433	ambient
1120	NO2	1.375	ambient
1121	NOx	1.856	ambient
1122	NOx	1.935	ambient
1126	NO2	0.123	zero
1127	NO2	0.118	zero
1128	NOx	0.577	zero
1129	NOx	0.591	zero
1130	NO2	0.162	zero
1132	NOx	0.431	zero
1133	NOx	0.521	zero
1136	NO2	1.881	soil
1137	NO2	2.256	soil
1138	NOx	4.699	soil
1139	NOx	5.923	soil
1140	NOx	6.799	soil
1141	NOx	7.59	soil
1142	NOx	8.33	soil
1143	NOx	9.07	soil
1144	NOx	9.73	soil
1145	NOx	10.45	soil
1146	NOx	11.08	soil
1147	NOx	11.59	soil
1148	NOx	11.97	soil
1149	NOx	12.38	soil
1150	NO2	1.965	soil
1151	NO2	1.092	soil
1152	NO2	0.977	soil
1153	NO2	0.941	soil
1154	NOx	12.14	soil
1155	NOx	13.59	soil
1156	NOx	13.79	soil
1157	NOx	13.86	soil
1158	NOx	13.93	soil
1159	NOx	14.2	soil
1200	NOx	14.45	soil
1201	NOx	14.58	soil
1202	NOx	14.65	soil
1203	NOx	14.83	soil
1204	NOx	14.9	soil
1205	NOx	15.11	soil
1206	NOx	15.28	soil
1207	NO2	1.805	soil - fan was turned on (not on before)
1208	NO2	0.879	soil
1209	NOx	15.98	soil
1210	NOx	17.56	soil
1211	NOx	17.65	soil
1212	NOx	17.63	soil
1213	NOx	17.62	soil
1214	NOx	17.64	soil
1215	NOx	17.66	soil
1216	NOx	17.7	soil
1217	NOx	17.67	soil
1218	NOx	17.63	soil
1219	NO2	1.609	soil
1220	NO2	0.892	soil
1222	NO2	1.267	ambient
1223	NO2	1.234	ambient
1224	NOx	1.471	ambient
1225	NOx	1.452	ambient
1226	NO2	1.138	ambient
1227	NO2	1.139	ambient
1228	NOx	1.421	ambient
1229	NOx	1.349	ambient
1231	NOx	0.34	zero
1232	NOx	0.495	zero
1233	NO2	0.199	zero
1234	NO2	0.165	zero

TIME	PANEL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	PRESSURE (mb)	RH (%)	AIR TEMP (C)
1115	37.9	31.45	29.08	28.01	994		
1120	38.31	31.79	29.07	28.11	994	- Vaisalla data N/A, therefore humidity and temperature recorder used	
1125	38.69	32.43	28.87	28.5	994		
1130	39.06	31.97	28.47	28.83	994		
1135	38.83	31.84	28.41	29.16	994		
1140	37.51	31.52	28.27	29.92	994		
1145	36.9	31.16	28.09	30.07	994	- ambient RH from 40% at 11:00 to 35% at 12:30	
1150	38.06	31.13	28.1	30.56	994		
1155	38.79	31.58	28.23	31.02	994		
1200	38.96	32.13	28.37	31.27	994		
1205	39.24	32.29	28.37	31.47	994	- ambient air temp. was 32 C	
1210	39.78	32.45	28.26	31.7	994		
1215	40.32	33.29	28.36	32.33	994		
1220	41.08	33.29	28.2	32.84	994		
1225	41.44	33.69	28.25	33.41	994		
1230	41.67	33.6	28.13	33.72	994		

WEATHER:

TEMPERATURE: 32 C

WIND: 8 KNOTS G 11 KNOTS AT 15

CLOUD COVERAGE: 6/10 high Ci

TIME: 12:46

Pre-run calibration achieved at 15.25 ppbv.

Table A17 - EGBERT SOURCE DATA (Site ...w - August 1, 1989 - Grass, Watered)

TIME	STATUS	NOx (ppb)	COMMENTS
1237	NO2	1.093	soil
1238	NO2	0.934	soil
1239	NOx	4.883	soil
1240	NOx	6.046	soil
1241	NOx	8.21	soil
1242	NOx	9.51	soil
1243	NOx	10.78	soil
1244	NOx	11.98	soil
1245	NOx	13.12	soil
1246	NOx	14.2	soil
1247	NOx	15.22	soil
1248	NOx	16.2	soil
1249	NOx	17.11	soil
1250	NOx	18.01	soil
1251	NOx	18.85	soil
1252	NOx	19.6	soil
1253	NOx	20.28	soil
1254	NO2	1.538	soil
1255	NO2	0.523	soil
1256	NOx	20.3	soil
1257	NOx	23.2	soil
1258	NOx	23.94	soil
1259	NOx	24.62	soil
1300	NOx	25.32	soil
1301	NOx	25.94	soil
1302	NOx	26.55	soil
1303	NOx	27.1	soil
1304	NOx	27.61	soil
1305	NOx	28.11	soil
1306	NOx	28.62	soil
1307	NOx	29.11	soil
1308	NOx	29.57	soil
1309	NOx	30.03	soil
1310	NOx	30.44	soil
1311	NOx	30.83	soil
1312	NOx	31.13	soil
1313	NOx	31.5	soil
1314	NOx	31.93	soil
1315	NOx	32.48	soil
1316	NOx	32.96	soil
1317	NOx	33.43	soil
1318	NOx	33.85	soil
1319	NOx	34.33	soil
1320	NOx	34.87	soil
1321	NOx	35.36	soil
1322	NOx	35.8	soil
1323	NOx	36.29	soil
1324	NOx	36.75	soil
1325	NOx	37.26	soil
1326	NOx	37.74	soil
1327	NOx	38.21	soil
1328	NOx	38.54	soil
1329	NOx	39.06	soil
1330	NOx	38.89	soil
1331	NOx	38.93	soil
1332	NOx	39.3	soil
1333	NOx	39.64	soil
1334	NOx	40.02	soil
1335	NOx	40.3	soil
1336	NOx	40.51	soil
1337	NOx	40.83	soil
1338	NOx	41.09	soil
1339	NOx	41.37	soil
1340	NOx	42.07	soil
1341	NOx	42.43	soil
1342	NOx	42.82	soil
1343	NOx	43.08	soil
1344	NOx	43.33	soil
1345	NOx	43.49	soil
1346	NOx	43.77	soil
1347	NOx	44.14	soil
1348	NOx	44.45	soil
1349	NOx	44.81	soil
1350	NOx	44.93	soil
1351	NOx	45.06	soil
1352	NOx	45.32	soil
1353	NOx	45.7	soil
1354	NOx	46.12	soil
1355	NOx	46.5	soil
1356	NOx	46.66	soil
1357	NOx	46.8	soil
1358	NOx	47	soil
1359	NOx	47.08	soil
1400	NOx	47.06	soil

TIME	PANEL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	PRESSURE (mb)	RH (%)	AIR TEMP (C)
1240	42.02	33.98	28.39	33.95	995		
1245	41.84	34.09	28.46	33.91	995		
1250	41.68	34.14	28.61	34.04	995		
1255	40.9	34	28.54	33.81	995		
1300	41.1	33.76	28.25	33.59	995		
1305	42.49	34.32	28.42	34.05	995		
1310	43.52	34.31	28.33	34.52	994		
1315	43.86	34.29	28.27	34.8	995		
1320	44.47	33.84	27.88	34.73	995		
1325	45.1	33.69	27.87	35.08	995		
1330	45.64	33.67	27.94	35.48	995		
1335	46.65	33.99	28.31	36.11	995		
1340	46.51	33.97	28.45	36.64	995		
1345	47.48	33.77	28.49	36.77	995		
1350	48.18	33.67	28.7	37.28	995		
1355	48.04	33.61	28.99	37.61	995		
1400	48.6	33.47	29.28	37.56	995		
1405	49.44	33.84	29.5	37.6	995		
1410	49.36	35.95	32.76	37.12	995		

- Vaisalla data N therefore humid and temperature recorder used
- ambient RH from 35% at 12:30 to 33% at 14:00
- ambient air temperature was 33 C

WEATHER:

TEMPERATURE: 33 C

WINDS: 8 KNOTS G 11 KNOTS AT 15

TIME: 12:46

TIME	STATUS	NOx (ppb)	COMMENTS
1401	NOx	47.21	soil
1403	NO2	1.106	ambient
1404	NO2	1.008	ambient
1405	NOx	1.594	ambient
1406	NOx	1.479	ambient
1408	NO2	0.087	zero
1409	NO2	0.106	zero
1410	NOx	0.553	zero
1411	NOx	0.608	zero

Table A18 - EGBERT SOURCE DATA (Site 5c - August 1, 1989 - Grass)

TIME	STATUS	NOx (ppb)	COMMENTS
1429	NOx	1.641	ambient
1430	NOx	1.828	ambient
1431	NOx	1.638	ambient
1432	NOx	1.521	ambient
1433	NO2	0.89	ambient
1434	NO2	0.846	ambient
1436	NO2	-0.112	zero
1437	NO2	-0.134	zero
1438	NOx	0.204	zero
1439	NOx	0.246	zero
1442	NO2	1.222	soil
1443	NO2	1.501	soil
1444	NOx	4.973	soil
1445	NOx	6.198	soil
1446	NOx	6.358	soil
1447	NOx	6.137	soil
1448	NOx	6.274	soil
1449	NOx	6.566	soil
1450	NOx	6.77	soil
1451	NOx	6.987	soil
1452	NOx	8	soil - up until 14:51 the chamber was not firmly on the skirt
1453	NOx	8.92	soil
1454	NOx	9.84	soil
1455	NOx	10.76	soil
1456	NO2	2.232	soil
1457	NO2	1.345	soil
1458	NOx	9.9	soil
1459	NOx	10.99	soil
1500	NOx	11.32	soil
1501	NOx	11.41	soil
1502	NOx	11.5	soil
1503	NOx	11.98	soil
1504	NOx	12.49	soil
1505	NOx	13.1	soil
1506	NOx	13.36	soil
1507	NOx	13.79	soil
1508	NOx	14.27	soil
1509	NOx	14.75	soil
1510	NOx	15.24	soil
1511	NOx	15.62	soil
1512	NOx	15.3	soil
1513	NOx	14.69	soil
1514	NOx	14.6	soil
1515	NOx	14.79	soil
1517	NO2	1.678	soil
1518	NO2	1.773	soil
1520	NO2	0.84	ambient
1521	NO2	0.784	ambient
1522	NOx	1.2	ambient
1523	NOx	1.114	ambient
1525	NO2	-0.282	zero
1526	NO2	-0.262	zero
1527	NOx	-0.081	zero
1528	NOx	-0.056	zero

TIME	PANEL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	PRESSURE (mb)	RH (%)	AIR TEMP (C)
1430	48.79	37.96	37.43	38.72	996		
1435	49.11	37.59	38.49	38.53	996	- Vaisalla data N/A, therefore humidity and temperature recorder used	
1440	49.32	37.43	39.3	38.72	996		
1445	49.64	37.08	39.43	39.77	996		
1450	49.91	36.94	39.9	39.66	996		
1455	49.3	36.69	40.11	39.42	996		
1500	46.36	36.66	39.41	38.78	997	- ambient RH from 33% at 14:30 to 35% at 15:30	
1505	46.54	35.65	39.1	38.73	997		
1510	48.38	35.2	40.02	39.9	996		
1515	48.86	35.53	40.87	40.82	996		
1520	48.25	35.45	40.76	40.67	996	- ambient air temperature was 32 C	
1525	48.13	35.36	40.89	40.7	996		

WEATHER:

TEMPERATURE: 32 C

WINDS: 20 KNOTS G 30 KNOTS AT 340

CLOUD COVERAGE: 7/10 Cu

TIME: 15:59

Table A19 - EGBERT SOURCE DATA (Site 5cw - August 1, 1989 - Grass)

TIME	STATUS	NOx (ppb)	COMMENTS
1530	NO2	0.857	soil
1531	NO2	0.997	soil
1532	NO2	0.997	soil
1533	NOx	6.203	soil
1534	NOx	8.67	soil
1535	NOx	10.82	soil
1536	NOx	12.9	soil
1537	NOx	14.79	soil
1538	NOx	15.65	soil
1539	NOx	15.65	soil
1540	NOx	15.45	soil
1541	NOx	16.6	soil
1542	NOx	18.45	soil
1543	NOx	20.51	soil
1544	NOx	22.46	soil
1545	NOx	24	soil
1546	NOx	24.13	soil
1547	NOx	23.99	soil
1548	NOx	24.34	soil
1549	NOx	26.19	soil
1550	NOx	27.76	soil
1551	NO2	3.541	soil
1552	NO2	0.986	soil
1553	NO2	0.941	soil
1554	NOx	24.64	soil
1555	NOx	28.27	soil
1556	NOx	26.59	soil
1557	NOx	24.85	soil
1558	NOx	22.99	soil
1559	NOx	20.81	soil
1600	NOx	19.9	soil
1601	NOx	19.34	soil
1602	NOx	18.76	soil
1604	NO2	6.983	ambient
1605	NO2	6.752	ambient
1606	NO2	6.668	ambient
1607	NOx	6.862	ambient
1608	NOx	6.739	ambient
1610	NO2	-0.381	zero
1611	NO2	-0.504	zero
1612	NO2	-0.512	zero
1613	NOx	-0.383	zero
1614	NOx	-0.428	zero

TIME	PANEL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	SOIL TEMP (C)	PRESSURE (mb)	RH (%)	AIR TEMP (C)
1530	47.86	35.31	41.24	40.95	997		
1535	48.18	35.06	41.38	41.23	996		
1540	49.07	34.88	41.59	41.47	996		
1545	46.98	35.1	41.18	41.2	997		
1550	43.8	35.13	39.91	39.99	997		
1555	41.01	34.57	38.36	38.6	997		
1600	38.61	34.14	37.14	37.56	997		
1605	36.4	33.57	35.97	36.5	997		
1610	34.9	32.59	32.94	33.97	997		

- Vaisalla data N/A, therefore humidity and temperature recorder used
- ambient RH from 38% at 15:30 to 49% at 16:00
- ambient air temperature from 31 C at 15:30 to 27 C at 16:00

WEATHER:

TEMPERATURE: 31 C AT 15:30
27 C AT 16:00

WINDS: 20 KNOTS G 30 KNOTS AT 340 (TIME: 16:00)

CLOUD COVERAGE: 7/10 Cu

OTHER: -getting cooler
- looks like showers are developing

Table A20 - EGBERT SOURCE DATA (Site 6c - August 24-25, 1989 - Alfalfa)

TIME	Soil Emissions		Zero Air		Soil Emissions			
	NOx (ppb)	Aver. NO2 (ppb)	Zero NOx (ppb)	Zero NO2 (ppb)	NO (ppb)	NO (ppb) Corr.	Aver. No Corr.	STD NO Corr.
1432	18.80	0.72	-0.43	-0.34	18.17	17.44	17.65	0.45
	18.60				17.97	17.24		
	19.60				18.97	18.27		
1632	14.10	0.26	-0.40	-0.47	13.77	12.95	13.86	0.68
	15.00				14.67	13.86		
	14.90				14.57	13.76		
	16.00				15.67	14.88		
1832	8.90	0.00	-0.57	-0.50	8.97	8.44	7.95	0.29
	8.10				8.17	7.84		
	8.10				8.17	7.84		
	7.90				7.97	7.68		
2032	5.70	-0.38	-0.51	-0.56	6.03	6.16	6.16	0.06
	5.60				5.93	6.08		
	5.80				6.13	6.24		
	5.70				6.03	6.16		
2232	4.00	0.13	-0.48	-0.52	3.83	4.29	4.29	0.06
	4.00				3.83	4.29		
	4.10				3.93	4.38		
	3.90				3.73	4.20		
32	3.40	0.40	-0.46	-0.49	2.96	3.50	3.19	0.24
	3.10				2.66	3.21		
	2.70				2.26	2.82		
	3.10				2.66	3.21		
232	2.30	-0.01	-0.45	-0.50	2.26	2.82	2.54	0.22
	2.10				2.06	2.62		
	2.00				1.96	2.51		
	1.70				1.66	2.20		
432	1.70	-0.16	-0.43	-0.48	1.82	2.37	2.45	0.09
	1.70				1.82	2.37		
	1.80				1.92	2.47		
	1.90				2.02	2.58		
632	2.00	0.08	-0.43	-0.47	1.87	2.43	2.30	0.17
	1.60				1.47	2.01		
	1.90				1.77	2.33		
	2.00				1.87	2.43		
832	3.80	0.52	-0.45	-0.52	3.21	3.73	3.50	0.14
	3.50				2.91	3.45		
	3.40				2.81	3.36		
	3.50				2.91	3.45		
1032	6.10	0.08	-0.47	-0.56	5.93	6.08	6.65	0.57
	6.40				6.23	6.32		
	6.80				6.63	6.64		
	8.00				7.83	7.58		
1232	10.70	0.18	-0.51	-0.61	10.42	9.51	9.96	0.33
	11.20				10.92	9.87		
	12.00				11.72	10.44		
	11.40				11.12	10.01		

Table A21 - EGBERT SOURCE DATA (Site 6d - August 30-31, 1989 - Alfalfa)

TIME	Soil Emissions NOx (ppb)	Soil Emissions Aver. NO2 (ppb)	Zero Air Zero NOx (ppb)	Zero Air Zero NO2 (ppb)	Soil Emissions NO (ppb)	Soil Emissions NO (ppb) Corr.	Soil Emissions Aver. No Corr.	Soil Emissions STD NO Corr.
1226	8.00	0.05	-0.21	-0.22	7.94	7.94	8.04	0.07
	8.20				8.14	8.09		
	8.20				8.14	8.09		
1426	8.60	-0.03	-0.19	-0.21	8.61	8.46	8.87	1.04
	8.10				8.11	8.07		
	8.40				8.41	8.30		
	11.50				11.51	10.66		
1626	9.50	-0.16	-0.15	-0.17	9.64	9.26	10.32	1.45
	10.00				10.14	9.64		
	9.90				10.04	9.57		
	12.90				13.04	12.82		
1826	7.10	-0.14	-0.19	-0.23	7.20	7.34	7.88	0.78
	7.20				7.30	7.42		
	7.30				7.40	7.51		
	9.50				9.60	9.23		
2026	5.10	-0.25	-0.27	-0.28	5.34	5.79	5.85	0.04
	5.20				5.44	5.87		
	5.20				5.44	5.87		
	5.20				5.44	5.87		
2226	4.30	-0.23	-0.26	-0.29	4.50	5.06	5.06	0.06
	4.40				4.60	5.14		
	4.30				4.50	5.06		
	4.20				4.40	4.97		
26	3.20	-0.28	-0.26	-0.28	3.46	4.10	4.56	0.28
	3.70				3.96	4.56		
	3.90				4.16	4.74		
	4.00				4.26	4.83		
226	3.20	-0.17	-0.26	-0.29	3.34	3.99	3.96	0.04
	3.20				3.34	3.99		
	3.20				3.34	3.99		
	3.10				3.24	3.89		
426	2.80	-0.23	-0.25	-0.28	3.01	3.67	3.62	0.05
	2.80				3.01	3.67		
	2.70				2.91	3.57		
	2.70				2.91	3.57		
626	2.20	-0.20	-0.26	-0.29	2.38	3.04	3.04	ERR
	2.20				2.38	3.04		
	2.20				2.38	3.04		
	2.20				2.38	3.04		
826	3.90	-0.19	-0.22	-0.28	4.03	4.63	4.51	0.10
	3.80				3.93	4.54		
	3.80				3.93	4.54		
	3.60				3.73	4.35		
1026	7.30	-0.18	-0.22	-0.24	7.46	7.55	7.51	0.32
	6.60				6.76	6.98		
	7.50				7.66	7.71		
	7.60				7.76	7.79		

Table A22 - EGBERT SOURCE DATA (Site 8 - September 12-13, 1989 - Alfalfa)

TIME	Soil Emissions		Zero Air		Soil Emissions			
	NOx (ppb)	Aver. NO2 (ppb)	Zero NOx (ppb)	Zero NO2 (ppb)	NO (ppb)	NO (ppb) Corr.	Aver. No Corr.	STD NO Corr.
1306	23.80	0.36	0.88	0.22	22.78	20.83	21.13	0.18
	24.20				23.18	21.23		
	24.30				23.28	21.32		
	24.10				23.08	21.13		
1506	15.00	0.42	0.24	0.20	14.53	12.86	11.34	1.10
	12.50				12.03	10.16		
	14.00				13.53	11.91		
	12.90				12.43	10.43		
1706	11.20	0.06	-0.02	-0.08	11.08	9.51	9.94	0.26
	12.20				12.08	10.19		
	12.00				11.88	10.06		
	11.90				11.78	9.99		
1906	8.30	-0.18	-0.08	-0.23	8.33	7.58	7.34	0.41
	8.30				8.33	7.58		
	8.30				8.33	7.58		
	7.00				7.03	6.62		
2106	7.70	-0.21	-0.17	-0.24	7.84	7.23	7.30	0.12
	7.90				8.04	7.37		
	8.00				8.14	7.45		
	7.60				7.74	7.15		
2306	9.00	-0.22	-0.23	-0.23	9.22	8.22	8.40	0.12
	9.20				9.42	8.36		
	9.40				9.62	8.50		
	9.40				9.62	8.50		
106	9.60	-0.23	-0.18	-0.21	9.80	8.63	8.68	0.06
	9.60				9.80	8.63		
	9.70				9.90	8.70		
	9.80				10.00	8.77		
306	9.10	-0.20	-0.21	-0.19	9.32	8.29	8.48	0.12
	9.40				9.62	8.50		
	9.50				9.72	8.57		
	9.50				9.72	8.57		
506	9.00	-0.21	-0.21	-0.22	9.21	8.21	8.35	0.09
	9.30				9.51	8.42		
	9.20				9.41	8.35		
	9.30				9.51	8.42		
706	9.10	-0.20	-0.21	-0.20	9.31	8.29	8.21	0.21
	9.20				9.41	8.36		
	8.50				8.71	7.86		
	9.20				9.41	8.36		
906	12.10	-0.19	-0.21	-0.22	12.28	10.32	10.17	0.37
	12.50				12.68	10.59		
	11.00				11.18	9.58		
	11.90				12.08	10.19		
1106	10.60	-0.18	-0.58	-0.18	11.18	9.58	9.53	0.06
	10.60				11.18	9.58		
	10.50				11.08	9.51		
	10.40				10.98	9.44		

APPENDIX B

METHOD OF CALCULATION OF NO FLUX

After equilibrium was attained:

$[NO]_i = [NO_x]_i - [NO_2]_i - [NO_x]_{i\text{-zero}} + [NO_2]_{i\text{-zero}}$ (all in ppbv)

Using the calibration equations determined in Appendix C, $[NO]_{i\text{-corr.}}$ was attained. Values were then averaged over the equilibrium period to attain $[NO]_{corr./aver.}$ (ppbv).

A = Soil Surface Area
= 30 cm x 30 cm
= 9.0×10^{-2} m^2

Q = Chamber Intake Air Flow

For sites 1a-5aw, 6c-8
Q = 4.0 L min^{-1}
= 6.67×10^{-2} L s^{-1}

For sites 5c, 5cw
Q = 5.0 L min^{-1}
= 8.33×10^{-2} L s^{-1}

Chamber air temperatures were averaged over the equilibrium period to attain $CAT_{aver.}$. At 20 °C (293 K), 1 ng(N) L^{-1} = 1.72 ppb. Therefore:

$$[NO]_{corr./aver.}\ (ng(N)L^{-1}) = \frac{[NO]_{corr./aver.}\ (ppbv)}{1.72\ (ppbv\ NO\ per\ ng(N)\ L^{-1}) * CAT_{aver.} / 293\ K}$$

$J(NO)\ (ng(N)\ m^{-2}s^{-1})$ = NO Flux $(ng(N)m^{-2}s^{-1})$
= $[NO]_{corr./aver.}$ $(ng(N)\ L^{-1})$ * Q (L s^{-1}) / A (m^2)
(see Figure B1)

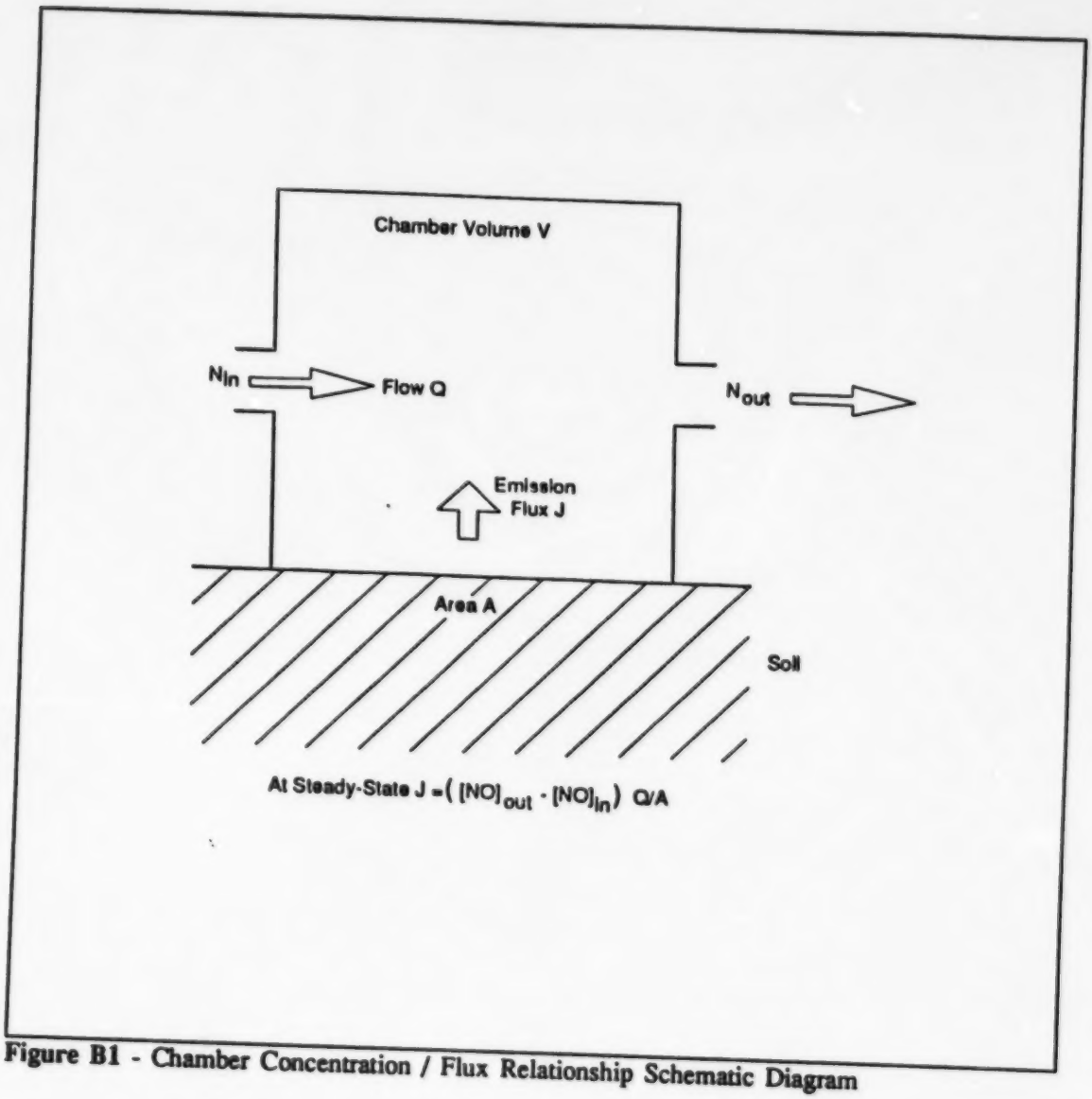

Figure B1 - Chamber Concentration / Flux Relationship Schematic Diagram

APPENDIX C

CALIBRATION OF NO, MONITOR

In June, before the Egbert study began, the Luminox LMA-3 monitor was calibrated in the laboratory. The calibrator (Monitor Labs Inc. Model 8550) was used to dilute NO, from a NO cylinder of known concentration (9.53 ppm NO of 0.11 ppm NO_2 impurity, Matheson), with scrubbed air. A calibration curve was produced by plotting the logarithm of the LMA-3 display against the logarithm of the calculated NO (Figure C1).

The calibration curve in Figure C1 was fitted to two linear sections (Y1 and Y2). The equation for the line of best fit for Y1 was $y = -0.160 + 1.26\ X$; for Y2 it was $y = 0.155 + 0.931\ X$.

At the beginning of each field day at Egbert the calibration of the Luminox LMA-3 monitor was checked using one point (11.9 ppb of NO). All NO soil emission data were adjusted using the above relationships with the intercept adjusted accordingly, ie., it was assumed that the slope of the calibration curve was unchanged. It should be noted that in the field the calibration of the LMA-3 monitor took a considerable amount of time (1-3 h) to stabilize.

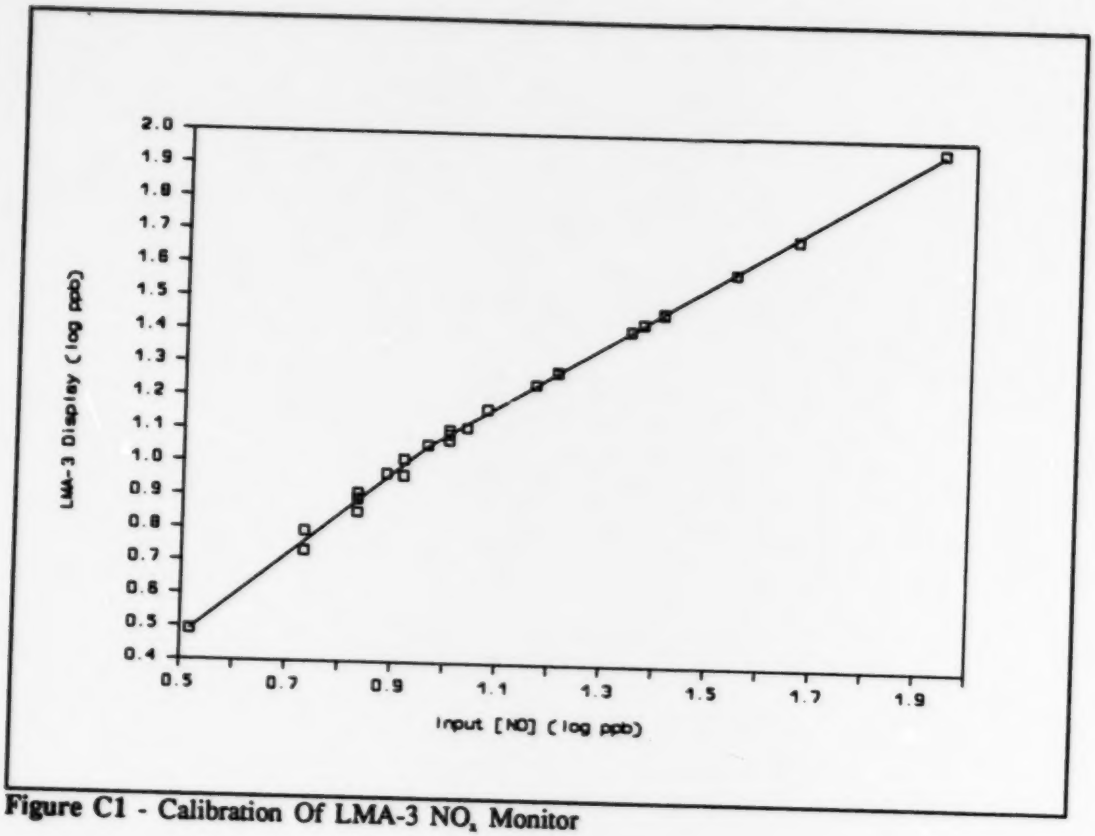

Figure C1 - Calibration Of LMA-3 NO_x Monitor

APPENDIX D

PLOTS OF NO FLUX AGAINST CHAMBER AIR TEMPERATURE, BAROMETRIC PRESSURE, SOIL FREE PORE VOLUME, CHAMBER RELATIVE HUMIDITY, AIR/SOIL TEMPERATURE DIFFERENCE AND SOIL WATER CONTENT

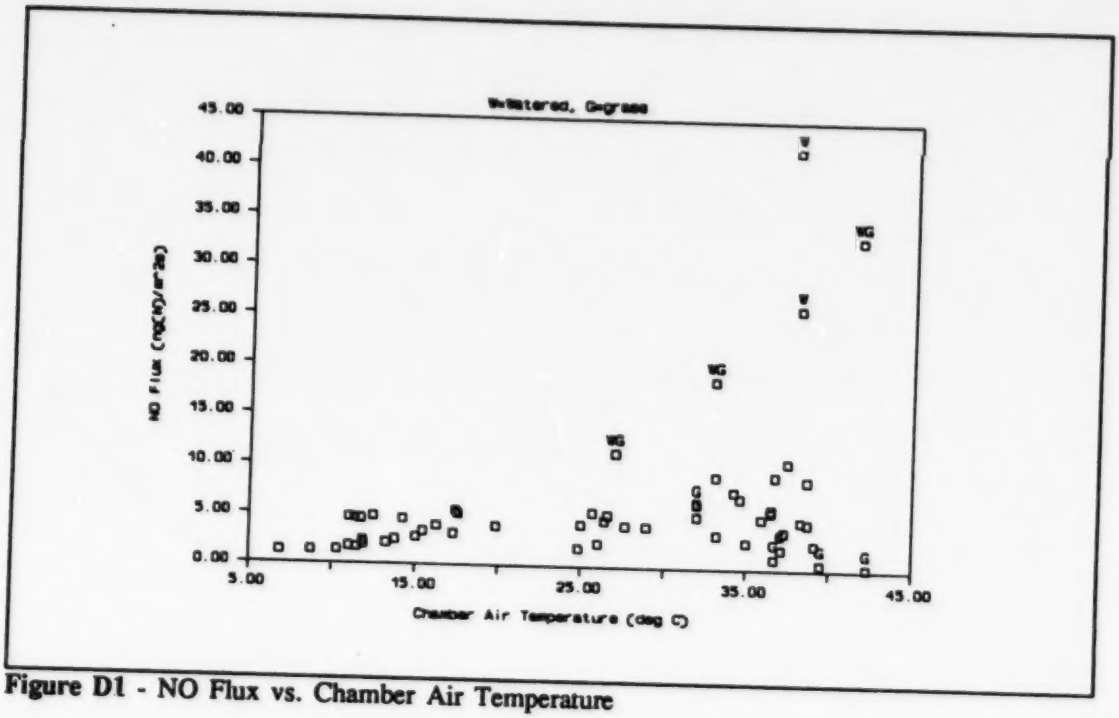

Figure D1 - NO Flux vs. Chamber Air Temperature

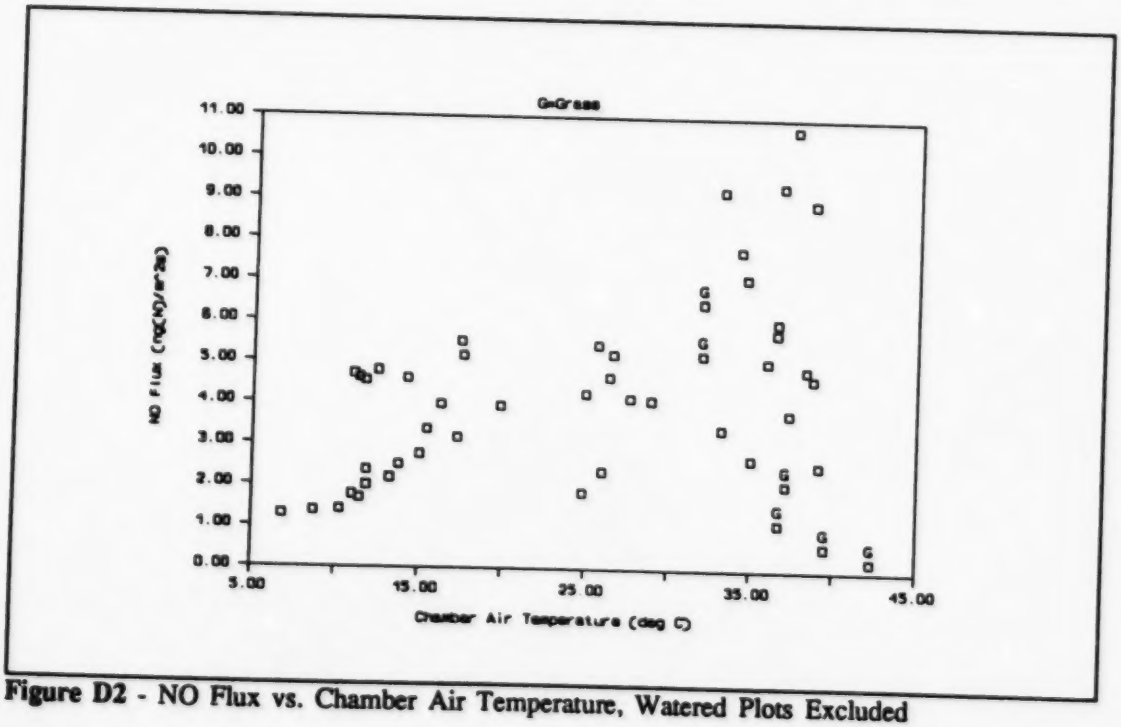

Figure D2 - NO Flux vs. Chamber Air Temperature, Watered Plots Excluded

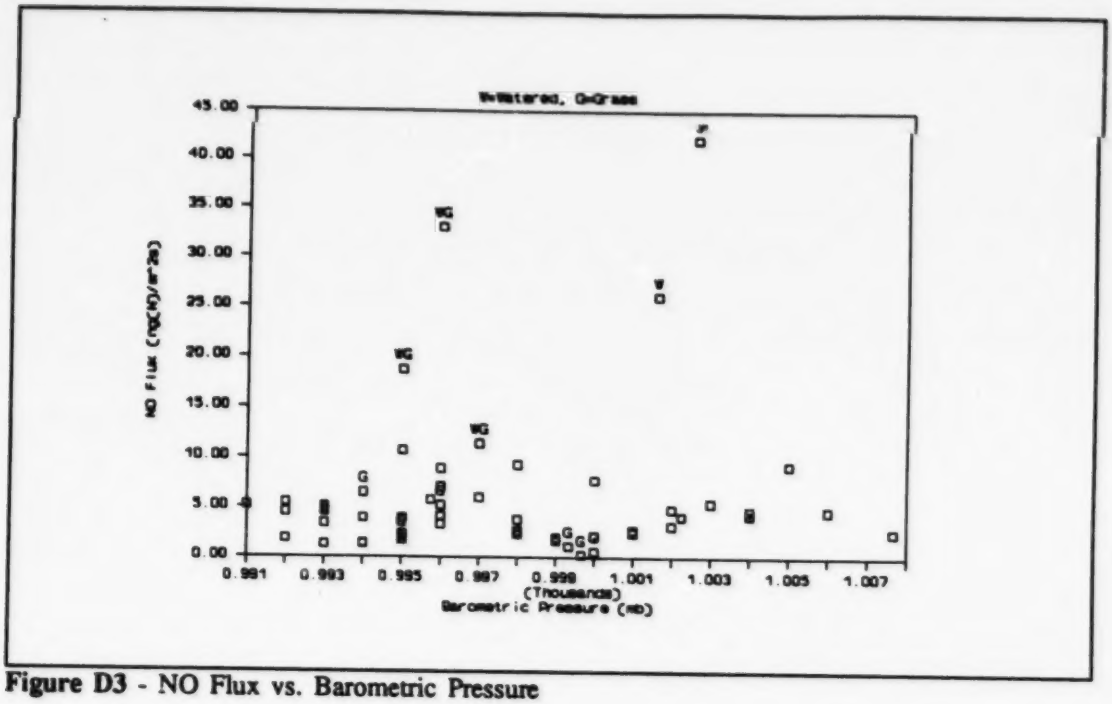

Figure D3 - NO Flux vs. Barometric Pressure

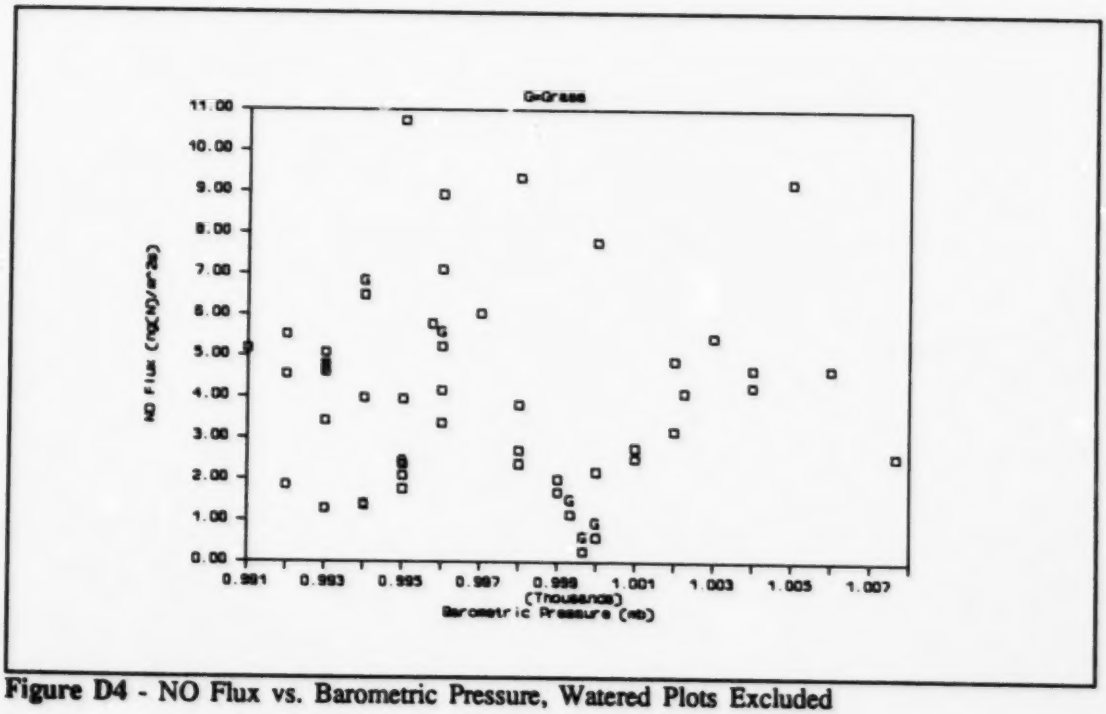

Figure D4 - NO Flux vs. Barometric Pressure, Watered Plots Excluded

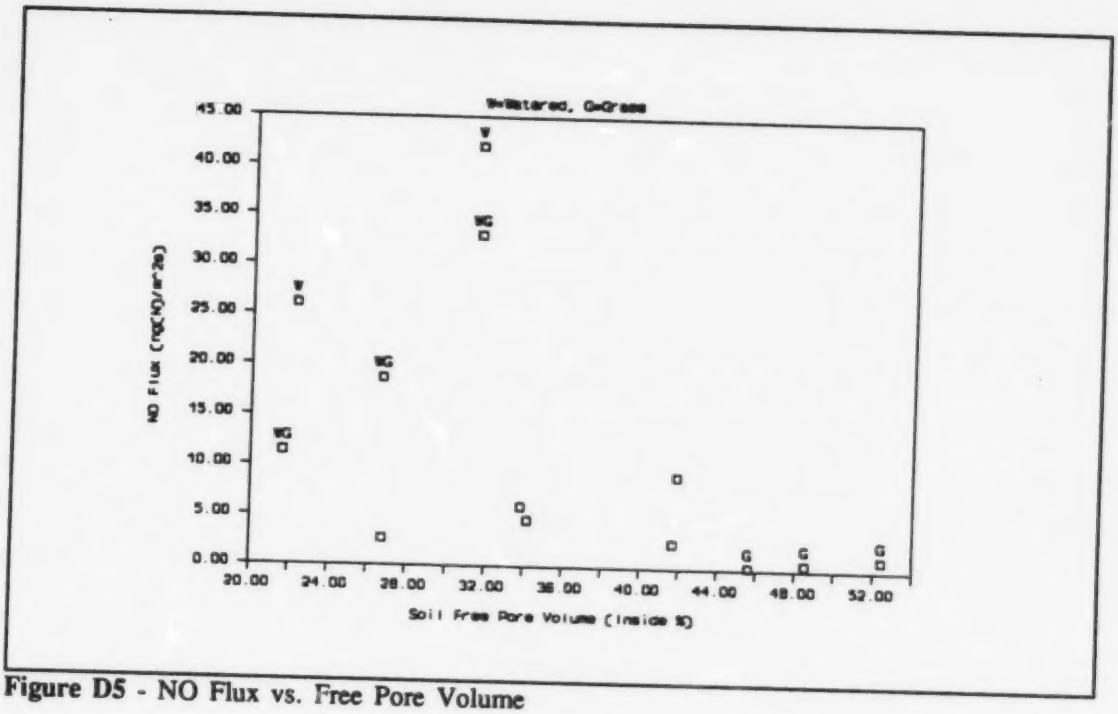

Figure D5 - NO Flux vs. Free Pore Volume

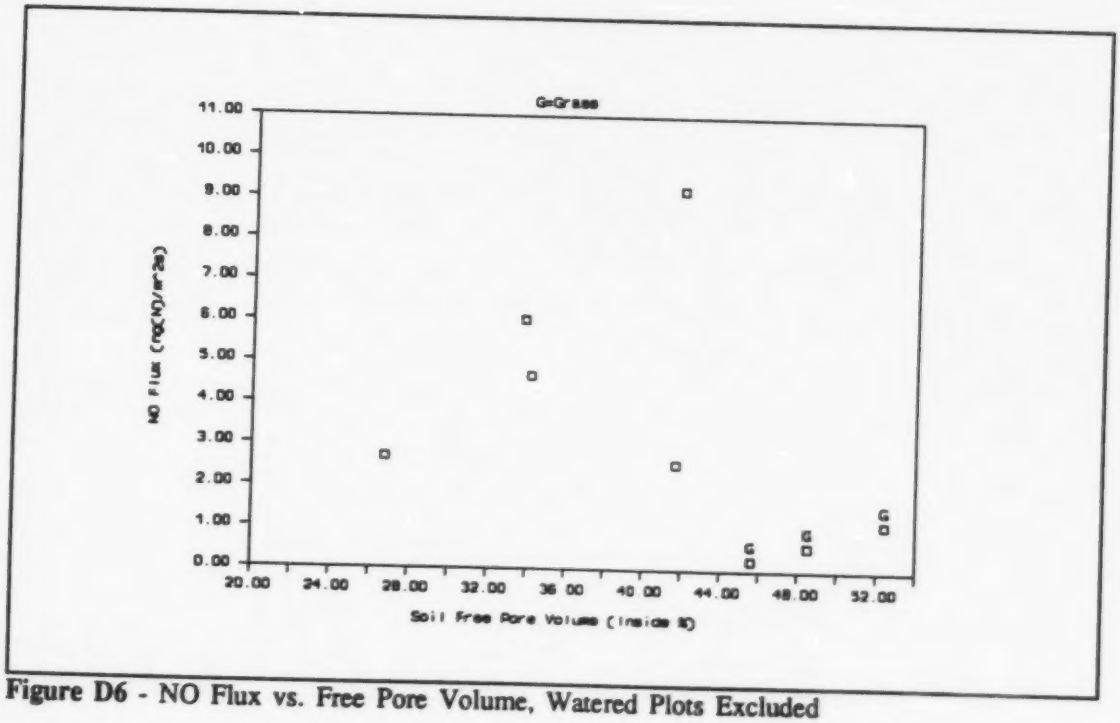

Figure D6 - NO Flux vs. Free Pore Volume, Watered Plots Excluded

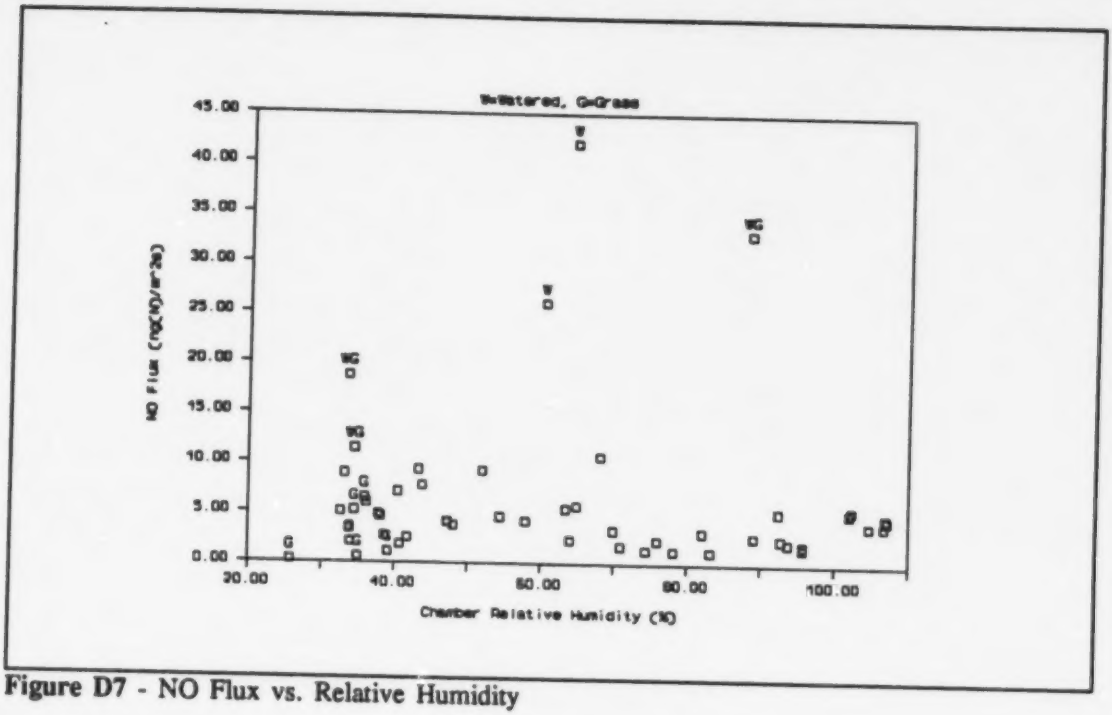

Figure D7 - NO Flux vs. Relative Humidity

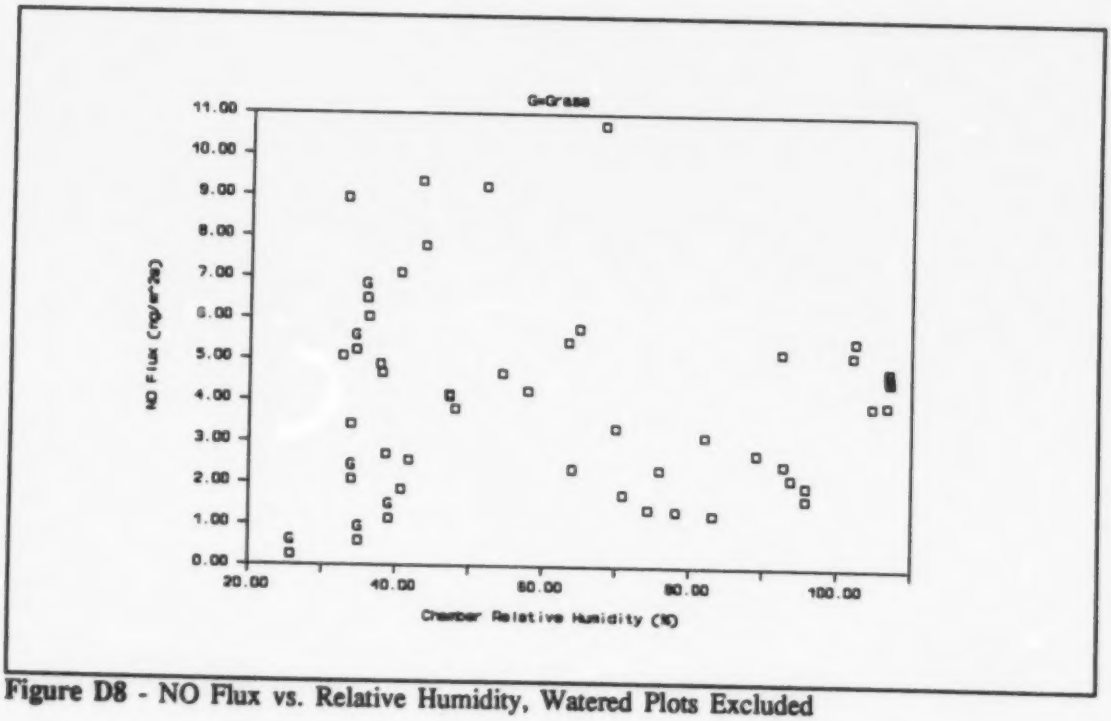

Figure D8 - NO Flux vs. Relative Humidity, Watered Plots Excluded

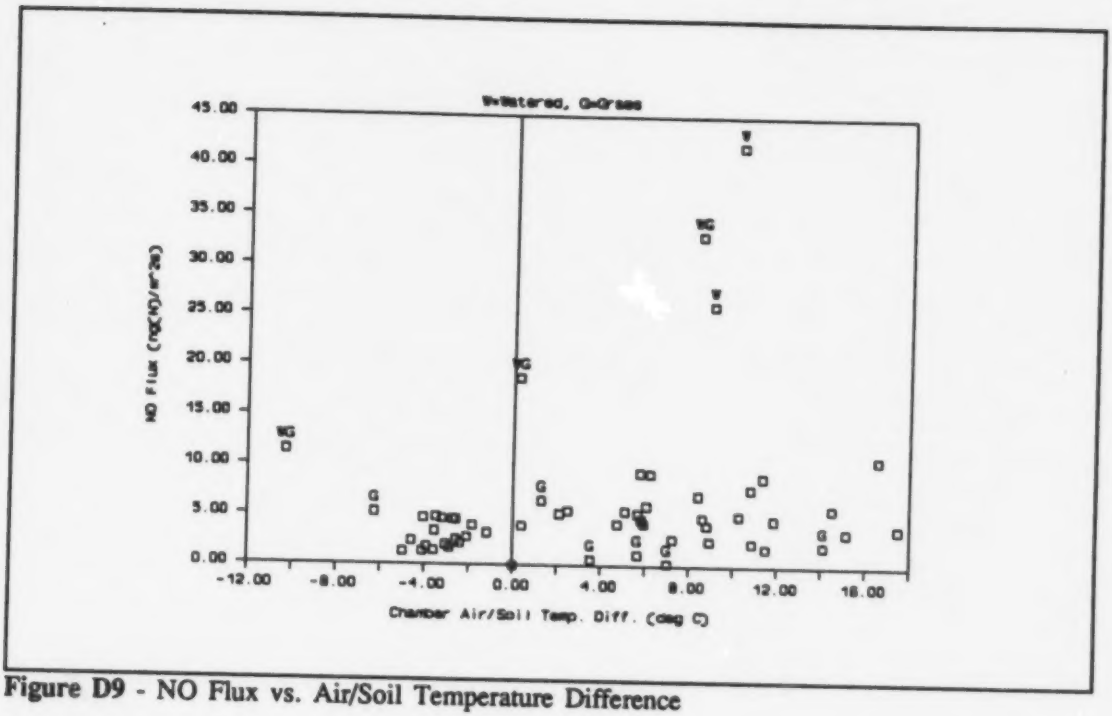

Figure D9 - NO Flux vs. Air/Soil Temperature Difference

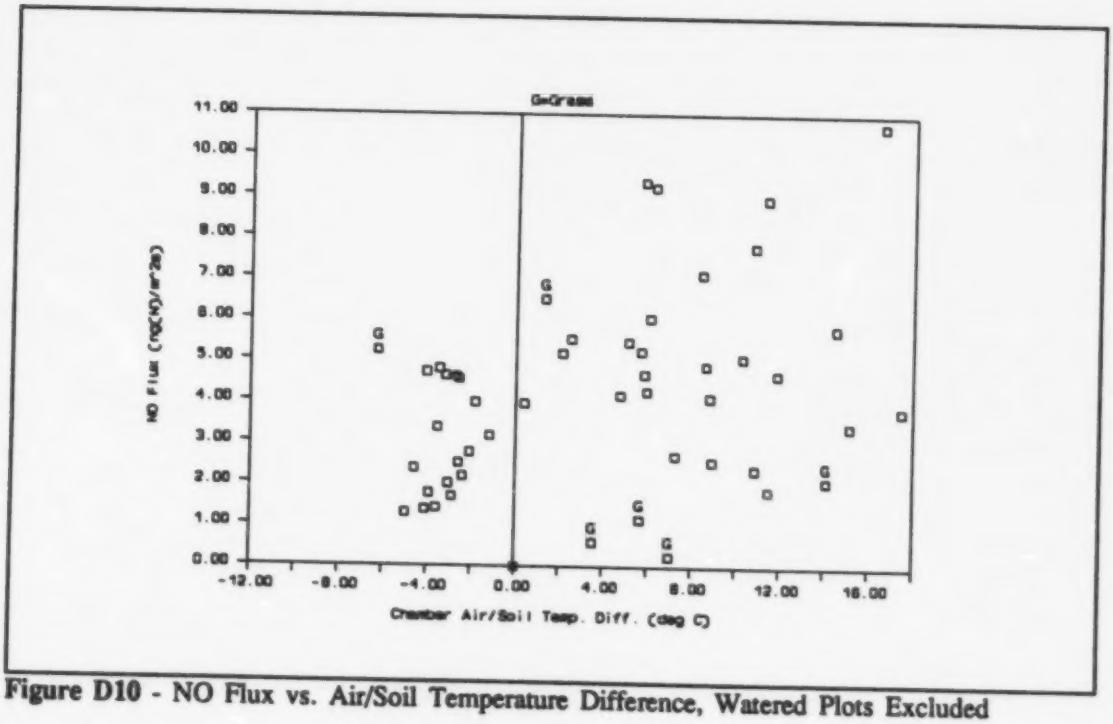

Figure D10 - NO Flux vs. Air/Soil Temperature Difference, Watered Plots Excluded

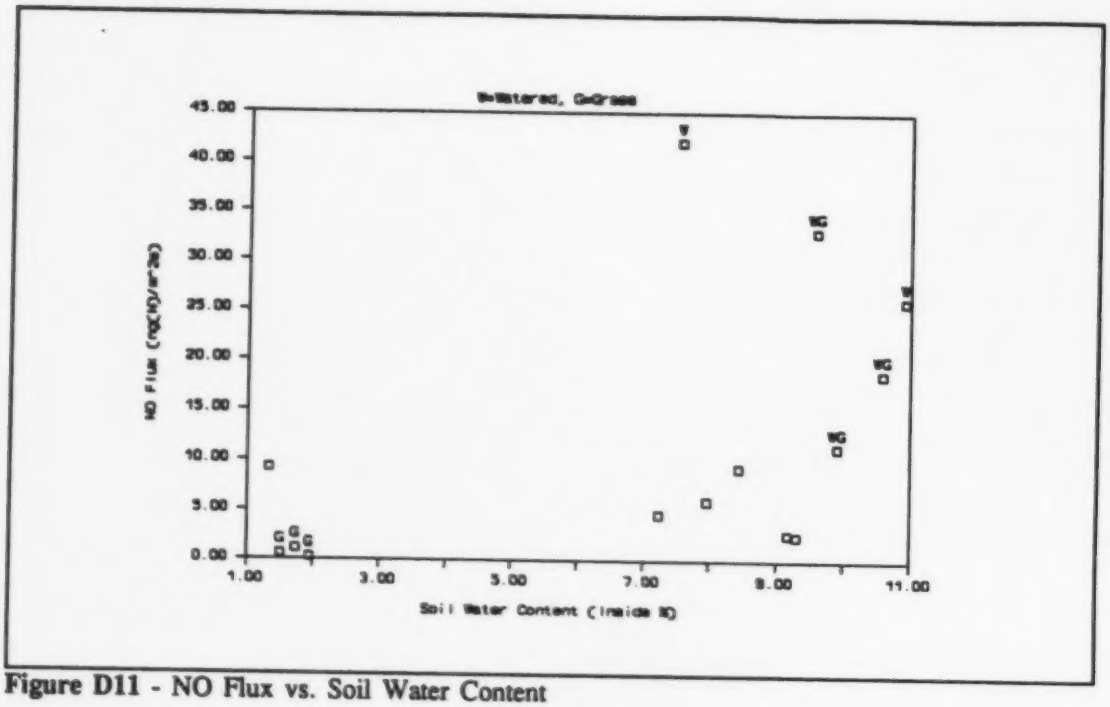

Figure D11 - NO Flux vs. Soil Water Content

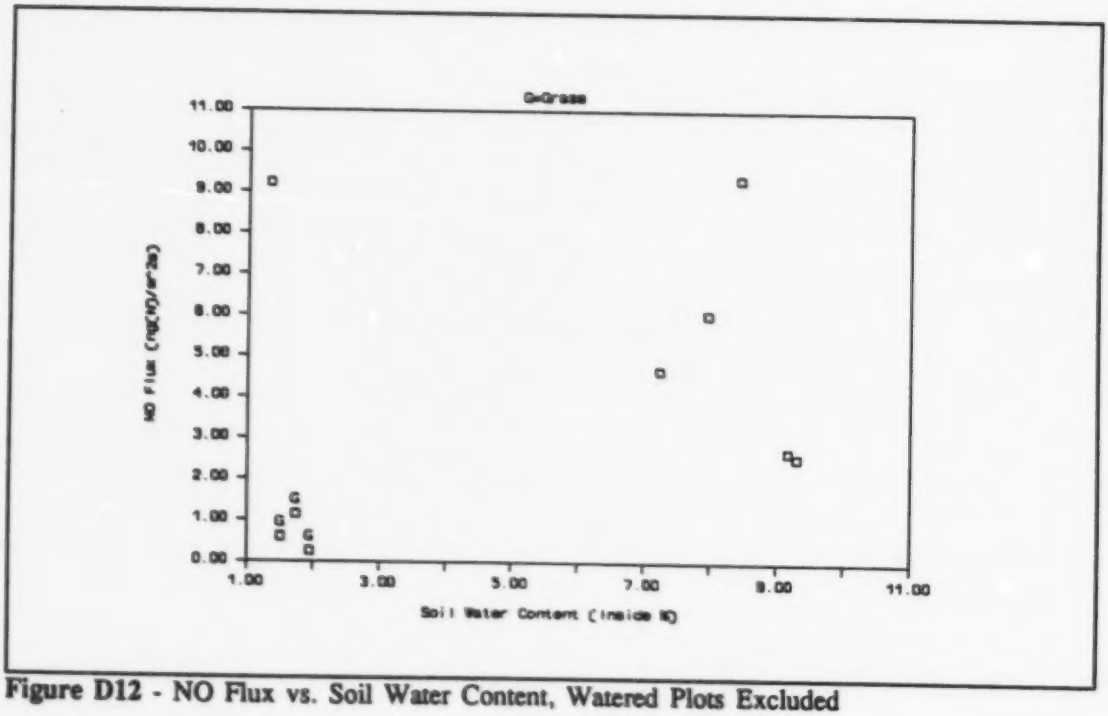

Figure D12 - NO Flux vs. Soil Water Content, Watered Plots Excluded